THE CANADIAN FIELD-NATURALIST

Volume 84

1970

THE OTTAWA FIELD-NATURALISTS' CLUB

OTTAWA CANADA

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist will be open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

Normally, only solicited reviews are published. The editor invites biologists and naturalists to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "Other New Titles".

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

(See Instructions to Contributors inside back cover)

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Volume 84, No. 1 Ottawa January-March, 1970

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Club is a corporate member of the Federation of Ontario Naturalists.

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by the Ottawa Field-Naturalists' Club with the assistance of affiliated societies and of a contribution from the Canadian National Sportsmen's Show. All material intended for publication should be addressed to the editor. Opinions and views expressed in this journal are private and do not necessarily reflect those of the Ottawa Field-Naturalists' Club or any other agency.

Membership and Subscription

The annual membership fee of $5.00 for individuals covers subscription to the journal. Libraries and other institutions may subscribe at the rate of $10.00 per year (volume). Applications for membership, subscriptions, changes of address and undeliverable copies should be mailed to: Treasurer, Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa 3, Canada. Return postage guaranteed.
Second class mail registration number 0527.

Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919, are obtainable from the Business Manager.

Cover: Wolf in Algonquin Provincial Park, Ontario. See article on Endangered Canadian Mammals by N. S. Novakowski in this issue. Photograph courtesy of Douglas H. Pimlott.

I would like to become a member of THE OTTAWA FIELD-NATURALISTS' CLUB and to receive the quarterly journal THE CANADIAN FIELD-NATURALIST

Name (Dr., Mr., Mrs., Miss) ______________________________

(In block letters)

Address ______________________________

____

____

____

(Include postal zone)

I would like my membership to start with

January of this year ☐

January of next year ☐

My membership fee of $5.00 is enclosed.

____

(Signature)

(Mail to) Treasurer,
Ottawa Field-Naturalists' Club,
Box 3264 Postal Station 'C',
Ottawa 3, Canada.

Please note that all library and institutional subscriptions to THE CANADIAN FIELD-NATURALIST are $10.00 a year (volume)

The Canadian Field-Naturalist

VOLUME 84 JANUARY-MARCH, 1970 NUMBER 1

TABLE OF CONTENTS

News and Comment

Letters

Reviews

Editorial Policy of the Canadian Field-Naturalist

In view of the changes in size and format of this journal beginning with the 1970 issues, it seems worthwhile to explain to the readership what the future might hold in store. The "new look" of this journal is the culmination of several years of thought and much recent discussion by many members who have long felt the need for improving the appearance of the journal and making its content as relevant as possible to the natural history needs of our time. I hope that the direction we are taking will meet with the overwhelming approval of the membership and of scientists, whose support we need. Additional changes in detail will, of course, continue to take place and to this end the editor would welcome suggestions.

The CANADIAN FIELD-NATURALIST is Canada's leading scientific journal in the field of natural history. In its back-volumes can be found a rich and varied storehouse of over 90 years of publication in the field. The publication of research and observations in all areas of natural history will continue for that is the basic purpose of this journal. Every consideration will continue to be given to the offerings of naturalists, not only because such offerings are so often worthwhile and valuable in themselves but also because this journal has a responsibility to support good observations by naturalists. However, because man is becoming more and more dependent on clean environments and on the balance of nature, and because nature and natural environments are being polluted, modified and/or eliminated over larger and larger regions of Earth, it is sensible and vitally important that the content of this journal reflect realistically the needs of the times.

It is my hope that the CANADIAN FIELD-NATURALIST will continue to move toward publishing a greater number of general and specialized research papers dealing with the environment and what is happening to it. The content of a journal is, of course, determined largely by the kinds of manuscripts offered for publication. Unlike strictly scientific journals, the CANADIAN FIELD-NATURALIST has a large potential readership among citizens at large. This journal is thus in a position to play a special role in Canada by serving as a communications medium between the scientist and the citizen on certain matters of joint concern to both. Papers published in this journal should have some social relevance in that they should relate to natural history or environment trends, or, they should implicitly support sound field-naturalist traditions. Those specialist research papers whose data or implications are not comprehensible to the intelligent naturalist, scientist or citizen would best be published in specialist journals available in Canada for the publication of such research. Ideally, the CANADIAN FIELD-NATURALIST should speak for natural history and environment in Canada in much the same way as the journals SCIENCE and NATURE speak for science in general.

The Ottawa Field-Naturalists' Club's financial resources for subsidizing the publication of the results of research are, of course, limited. At the same time, within the past year, publication costs have almost doubled and many more manuscripts are being offered to the journal. This means that we will have to be even more selective in the kinds of papers that are accepted for publication. Despite increased publication costs, membership in the club, for the present, is being maintained at only $5 per year, and subscriptions to institutions and libraries at $10 per year so as to encourage more widespread circulation to individuals and schools across the country. However, authors are being asked to assume a greater share of publication costs.

This reappraisal of editorial policy is based upon the strong feeling that the CANADIAN FIELD-NATURALIST could and should play an increasingly important role in helping Canadians protect or manage our living resources much more wisely than has been done in the past. The change in emphasis in editorial policy should also enable more scientists and citizens to work together in adopting more informed approaches toward the defence and rational use of the environment.

THEODORE MOSQUIN, Editor

Rare or Endangered Canadian Fishes[1]

D. E. McAllister
Curator of Fishes
National Museum of Natural Sciences
Ottawa, Canada

Abstract. This paper lists those Canadian species and subspecies which are potentially in danger of extinction in Canada, whose status would deserve further study, and which need public awareness so that no untoward actions will be taken. Included are: *Acipenser brevirostrum, Alosa aestivalis, Coregonus alpenae, Coregonus* sp., *Coregonus johannae, Salvelinus fontinalis timagamiensis, Hybognathus nuchalis nuchalis, Hybopsis x-punctata, Notropis anogenus, Rhinichthys cataractae* subsp., *Rhinichthys cataractae smithi, Rhinichthys osculus, Catostomus* sp., *Moxostoma hubbsi, Stizostedium vitreum glaucum, Cottus confusus,* and *Gasterosteus* sp.

Introduction

Each fish needs its own special world or habitat to live in. Its habitat may include cool, fast, pure water running over pebbles or it may be warm still water with lily pads. But without the special elements that make up its habitat it will not long survive.

The activities of modern man are changing the environment. Physical, chemical and biological changes are taking place with unprecedented magnitude and rapidity. For example, eutrophication of some of the largest lakes in North America, Lakes Erie, Ontario and Michigan, has taken place in the last 50 to 60 years. Due to introduction of the parasitic sea lamprey, the lake charr or trout has been decimated in the upper Great Lakes. It is the gradual rather than the most rapid changes which are most insidious, for they may pass unnoticed. Trautman (1957), Scott (1963) and Crossman (1968) review and document the effect of man's modification of the environment on the freshwater fish faunas of Ohio and Ontario. Kinds of man-made changes include:

1. Pollution, silting, or spraying of biocides, heating of water.
2. Dams, obstructions, river diversions, effects of farming, dredging, mining and logging operations including depletion of water supply, permanent and seasonal.
3. Introduction of exotic competitors, predators, or diseases.
4. Overfishing.

The following lists of species is provisional. More information is needed on many of the included species. This paper draws attention to this need for research. It also points out that care should be taken with these populations which may already be endangered.

Fishes included in the list are mainly those of restricted distribution. Widespread common species are little likely to become extinct, although they may disappear in part of their range (for example the deepwater sculpin (chabot de profondeur), *Myoxocephalus thompsonii* has not been seen in Lake Ontario for two or three years despite an active netting program, *in litt.* W. B. Scott, but is still apparently common elsewhere). Species restricted to a small local area, on the other hand, can easily be endangered.

This list considers solely those species occurring in Canada. Even if they occur elsewhere (in the United States), then they are included in the list. They are included for several reasons. Our fish fauna is part of our natural heritage which we wish to pass on to future generations to see and to enjoy. Often the Canadian fish populations are at the northern end of their range and are of scientific significance in studying limiting factors, zoogeography or genetics. Also we have no control over what happens to foreign populations. For example the shortnose sturgeon occurs in Canada only in the Saint John River, New Brunswick. In the U.S. it ranges all the way south to Florida, but is listed as endangered in the U.S. So the existence of U.S. populations is no necessary guarantee of the species survival.

[1]Solicited by the Editor

This list is concerned with Canada as a whole. So as long as there are adequate breeding populations in one province or another the species is not included in this list. However this does not prevent provincial action to ensure survival of all its species and subspecies. Thus Arctic charr are known in only two lakes in New Brunswick, but are common in Yukon, Northwest Territories and Quebec and so are not included in the list. Fishes which on rare occasions stray into Canadian waters and which do not migrate there or regularly reproduce there, are outside the scope of this list as there is little that can be done about them (e.g. spotted sucker (meunier tacheté), *Minytrema melanops,* reported by Crossman and Ferguson (1963)).

Some forms are restricted in distribution but are apparently in no danger. A dwarf form of the lake whitefish (corégone bossu), *Coregonus clupeaformis* occurs in Lake Opeongo in Algonquin Park, Ontario (Kennedy, 1943) but is unexploited and apparently in no danger (N. V. Martin, *in litt.*).

Remedial action may take several forms. Removal of the cause of danger may in some cases be effective. One may set aside part of present range as a refuge and ensure protection by adequate supervision. Laws giving total or regional protection may be passed. In case of overfishing, reduction in catch or complete cessation of fishing may be needed. Introduction of exotic forms should only be permitted after exhaustive analysis by competent specialists. The only way of maintaining some species may be by planting elsewhere or maintaining in aquaria.

The paddlefish (spatulaire), *Polyodon spathula,* has not been recorded in Canada for over 50 years and is probably extinct there. The blue walleye (doré bleu), *Stizostedium vitreum glaucum* may already be extinct.

The list is given below in table 1. It should be emphasized that this is simply a provisional list. Such is our state of knowledge that it is not certain that all species included are in danger. But they all certainly warrent investigation. Note that only the Canadian distribution is indicated in the table.

The list includes only those believed to be rare or endangered. But many other species are on the decrease. The last blackfin cisco (cisco à nageoires noires), *Coregonus nigripinnis,* caught in the Great Lakes was in 1955 (S. H. Smith *in litt.*) but still occurs elsewhere in Ontario. The grass pickerel (brochet vermiculé), *Esox americanus vermiculatus,* despite intense seinings around Montreal, is now very seldom seen (V. Legendre, *in litt.*). The Atlantic salman (saumon atlantique), *Salmo salar,* now rare in the United States is on the decline in Canada.

Immediate studies and action would be desirable. Minckley and Deacon's (1968) paper on the loss of the freshwater fish fauna of southwestern United States and Smith's (1968) on species changes in the Great Lakes are especially instructive and give warning that faunal changes are accelerating.

SHORTNOSE STURGEON; ESTURGEON À MUSEU COURT. *Acipenser brevirostrum.*

Anadromous. Known only in lower Saint John R., N.B. from mouth to Gagetown. Increasing pollution and a hydro-electric dam may be of significance in their survival. Scott and Crossman (1959), Vladykov and Greeley (1964), Gorham (1965), Leim and Scott (1967).

BLUEBACK HERRING; ALOSE D'ÉTÉ. *Alosa aestivalis.*

Anadromous. Known only in Bras d'or Lake, Shubenacadie and Stewiacke Rivers, N.S. and in lower Saint John R., N.B. (Specimens in National Museum of Natural Sciences). Leim and Scott (1967).

LONGJAW CISCO; CISCO À GRANDE BOUCHE. *Coregonus alpenae.*

Freshwater. Limited to depths at east end of Lake Erie (Dr. S. H. Smith, *in litt.*) or may be extinct (Crossman, 1968).

ATLANTIC WHITEFISH; CORÉGONE ATLANTIQUE. *Coregonus* sp.

Anadromous. Restricted to waters of Canada. Known only in Tusket R. system and

Millipsigate L., and Yarmouth Harb., southern N.S. Populations in the Tusket R., system may be influenced by power developments there (Dr. J. L. Hart, *in litt.*). Leim and Scott (1967), Scott (1967), Scott and Klawe (MS).

Deepwater cisco. Cisco de profondeur. *Coregonus johannae.*

Anadromous. Known in Ontario waters from Lake Huron. Last specimen was caught in 1951 (Dr. S. H. Smith, *in litt.*). Scott and Smith (1962), Scott (1967).

Brook charr or trout ("aurora trout"); Omble de fontaine. *Salvelinus fontinalis timagamiensis.*

Freshwater. Restricted to waters of Canada. Known only in Whirligig and Wilderness Lakes, 90 mi. northwest of North Bay, Ont. Planted in Temiskaming and in Cochrane District. Qadri (1968 and *in litt.*), Sale (1957).

Silvery minnow; Méné argenté. *Hybognathus nuchalis nuchalis.*

Freshwater. Known only in the Milk River system, southern Alta. Willock (1968).

Gravel chub; Gravelier. *Hybopsis x-punctata.*

Freshwater. Known only from Thames R., Ont., (Dr. R. M. Bailey, *in litt.*). Scott (1967).

Pugnose shiner; Méné camus. *Notropis anogenus.*

Freshwater. Known only from two areas on the Ontario shore of Lake Erie and from the outlet of Lake Ontario (Dr. R. M. Bailey, *in litt.*). Sensitive to increases in turbidity and reduction of aquatic vegetation. Bailey (1959).

Longnose dace; Goujon à long nez. *Rhinichthys cataractae* subsp.

Freshwater. Known only in Nooksack River, southwestern B.C. (Dr. J. D. McPhail, *in litt.*).

Longnose dace; Goujon à long nez. *Rhinichthys cataractae smithi.*

Freshwater. Known only in Cave and Basin Hotspring, Banff National Park, Alta. Taxonomic distinctness not verified. May already be extinct following introduction of tropical fishes. None in 2 collections made in 1968. McAllister (1969).

Speckled dace; Naseux moucheté. *Rhinichthys osculus.*

Freshwater. Known only from 3 localities in the Kettle R., southern B.C. Carl, Clemens and Lindsey (1959).

Sucker; Sucette. *Catostomus* sp.

Freshwater. Known only in the Salmon and Little Campbell Rivers, southeastern B.C. (*in litt.* Dr. J. D. McPhail).

Copper redhorse; Moxostome cuivre. *Moxostoma hubbsi.*

Freshwater. Restricted to waters of Canada. Known only in the St. Lawrence River, Quebec from Lac St. Pierre to the mouth of the Ottawa River. Legendre (1952), Scott (1967).

Blue walleye; Doré bleu. *Stizostedium vitreum glaucum.*

Freshwater. Now rare or perhaps even extinct in Lakes Erie and Ontario, probably due to the effects of pollution (Dr. S. H. Smith, *in litt.*). Scott (1967).

Shorthead sculpin; Chabot à tête courte. *Cottus confusus.*

Freshwater. Known only from the North Fork of the Flathead R., southeastern B.C. McAllister and Lindsey (1961), Bailey and Bond (1963).

Giant threespine stickleback; Grande épinoche à trois épines. *Gasterosteus* sp.

Freshwater. Restricted to waters of Canada. Known only from freshwaters of Queen Charlotte Island, under study by E. E. Moody, University of Alberta (*in litt.*, Dr. C. C. Lindsey).

Acknowledgments

The author is very grateful to the following persons for assisting this survey: Dr. K. R. Allen, Biological Station, Nanaimo, B.C.; Mr. F. M. Atton, Saskatchewan Fisheries Laboratory, Saskatoon; Mr. C. G. Gruchy, University of Ottawa; Dr. J. L. Hart, Biological Station, St. Andrews; M. V. Legendre, Service de la Faune du Québec, Montréal; Dr. C. C. Lindsey, University of Manitoba, Winnipeg; Mr. N. V. Martin, Ontario Department of Lands and Forests, Maple; Dr. J. D. McPhail, University of British Columbia, Vancouver; Dr. R. M. Bailey and Dr. R. R. Miller, University of Michigan, Ann Arbor; Dr. S. U. Qadri, University of Ottawa; Dr. W. B. Scott, Royal Ontario Museum, Toronto; Dr. S. H. Smith, Bureau of Commercial Fisheries, Ann Arbor; Mr. V. R. Taylor, Department of Fisheries, St. John's; Dr. N. J. Wilimovsky, University of British Columbia, Vancouver; Mr. T. Willock, National Museum of Natural Sciences, Ottawa.

Literature Cited

Bailey, R. M. 1959. Distribution of the American cyprinid fish *Notropis anogenus*. Copeia (2): 119-123, 1 figure.

Bailey, R. M. and **C. E. Bond.** 1963. Four new species of freshwater sculpins, genus *Cottus*, from Western North America. Occasional Papers of the Museum of Zoology, University of Michigan (634): 1-27, 4 figures.

Beeton, A. M. 1965. Eutrophication of the St. Lawrence Great Lakes. Limnology and Oceanography 10(2): 240-254, 4 figures.

Carl, G. C., Clemens, W. A. and **C. C. Lindsey.** 1967. The fresh-water fishes of British Columbia. British Columbia Provincial Museum Handbook (5): 1-192, illus.

Crossman, E. J. 1968. Changes in the Canadian freshwater fish fauna. Proceedings of the Twenty-first Meeting of the Canadian Committee on Freshwater Fisheries Research. Appendix I, 1 page.

Crossman, E. J. and **R. G. Ferguson** 1963. The first record from Canada of *Minytrema melanops*, the the spotted sucker. Copeia (1): 186-187.

Gorham, S. H. 1965. Notes on fishes from the Brown Flat area, Kings County, New Brunswick. The Canadian Field-Naturalist 79(2): 137-142, 1 map.

Kennedy, W. A. 1943. The whitefish, *Coregonus clupeaformis* (Mitchill), of Lake Opeongo, Algonquin Park, Ontario. Publications of the Ontario Fisheries Research Laboratory, University of Toronto Studies (51): 21-66.

Legendre, V. 1952. Les poissons d'eau douce. Tome 1. Clef des poissons de pêche sportive et commerciale de la province de Québec. Societé Canadienne d'Ecologie et Ministère de la Chasse et des Pêcheries, Province de Québec. 84 pages, 80 figures.

Leim, A. H. and **W. B. Scott.** 1967. Fishes of the Atlantic Coast of Canada. Bulletin of the Fisheries Research Board of Canada (155): 1-485, illustrated.

McAllister, D. E. 1969. Introduction of tropical fishes into a hotspring near Banff, Alberta. Canadian Field-Naturalist 83(1): 31-35, 2 figures.

McAllister, D. E. and **C. C. Lindsey.** 1961. Systematics of the freshwater sculpins (*Cottus*) of British Columbia. National Museum of Canada Bulletin (172): 66-89, 5 figures.

Minckley, W. L. and **J. E. Deacon.** 1968. Southwestern fishes and the enigma of "endangered species." Science 159: 1424-1432, 3 figures.

Qadri, S. U. 1968. Morphology and taxonomy of the aurora charr, *Salvelinus fontinalis timagamiensis*. National Museum of Canada Bulletin (237): 1-18, 5 figures.

Sale, P. F. 1967. A re-examination of the taxonomic position of the aurora trout. Canadian Journal of Zoology 45(2): 215-225, 1 figure.

Scott, W. B. 1963. A review of the changes in the fish fauna of Ontario. Transactions of the Royal Canadian Institute 34: 111-125.

————. 1967. Freshwater fishes of eastern Canada. University of Toronto Press, second edition, 137 pages, illustrated.

Scott, W. B. and **E. J. Crossman.** 1959. The freshwater fishes of New Brunswick: a checklist with distributional notes. Contributions of the Royal Ontario Museum, Division of Zoology and Palaeontology (51): 1-37 + appendix, 2 figures.

Scott, W. B. and **S. H. Smith.** 1962. The occurrence of the longjaw cisco, *Leucichthys alpenae*, in Lake Erie. Journal of the Fisheries Research Board of Canada 19(6): 1013-1023.

Smith, S. H. 1968. Species succession and fishery exploitation in the Great Lakes. Journal of the Fisheries Research Board of Canada 25(4): 667-693, 5 figures.

Trautman, M. B. 1957. The fishes of Ohio. Ohio State University Press, 683 pages, 7 plates, 172 figures, 172 maps.

Vladykov, V. D. and **J. R. Greeley.** 1964. Acipenseroidei. Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(3): 24-60, 10 figures.

Willock, T. 1968. Alberta records of the silvery and brassy minnows, stonecat and sauger, with a preliminary list of fishes of the Milk River in Alberta. Canadian Field-Naturalist 82(1): 18-23, 3 figures.

Received October, 1967
Accepted October, 1969

Rare or Endangered Canadian Amphibians and Reptiles[1]

FRANCIS R. COOK
Curator of Herpetology
National Museum of Canada
Ottawa, Ontario

Abstract. Of a total of 110 forms (included in 84 species) of amphibians and reptiles known to occur in Canada, at least 29 can be considered rare or endangered in this country with respect to either their entire Canadian distribution or to certain, usually relict, populations of particular interest. None of these forms are restricted to Canada and most are widespread and abundant over the United States portions of their range. However, because these populations are able to survive at the northern extremes of the tolerance for their species, and because they form part of the original fauna of Canada, they are of interest, and are worth preserving.

Destruction of habitat is perhaps the greatest danger to their continued survival. However, collecting, except when it is scientifically useful and does not itself endanger the form, should be discouraged. No Canadian estimates exist for any of these species, and even recent records of some forms are few or non-existent.

Only 84 species of amphibians and reptiles are recorded from Canada — barley over one percent of the 8100 species of these two classes surviving in the world today. Less than half of the Canadian species can be considered abundant and widespread throughout major areas of this country; the greatest numbers of different species are concentrated along our southern border, unfortunately coinciding with the density of the human population.

No species' range is entirely restricted to Canada, and very few, notably the Wood Frog, *Rana sylvatica,* the Mink Frog, *Rana septentrionalis,* and the Canadian Toad, *Bufo hemiophrys,* have the major part of their range or their centre of abundance in Canada. Only one subspecies, the Hudson Bay Toad, *Bufo americanus copei,* occurring in portions of northern Ontario and Quebec, is restricted to Canada, and its taxonomic validity is open to question. Another subspecies, the British Columbia Salamander, *Ambystoma gracile decorticatum,* is confined to Canada except for a portion of extreme southern Alaska. Each of these species or subspecies is widespread and abundant in remote areas and neither seems to be in danger from man's activities in the foreseeable future.

The problem in Canada, therefore, is not that of losing unique species or subspecies which are restricted to this country. Rather our "endangered species" are populations which are the northern extremes, and in some cases disjunct northern relicts, of species which are more or less abundant in the United States. However, these populations are important as Canadian examples of their species and because the individuals they consist of are at the northern limit of their species' ability to survive. None of the factors which limit them have been studied in detail, and they are well worth preserving for future research on this aspect alone, despite their apparent lack of specific or subspecific distinctiveness.

Economic Considerations

Although amphibians and reptiles doubtless play important parts in the ecosystems to which they belong, their roles have generally not been well studied. The majority are secondary or tertiary consumers, preying on a variety of forms—small birds, mammals, fish, insects and other reptiles or amphibians. None of our snakes, lizards, salamanders or frogs (after metamorphosis) feed on plants but many of the turtles and most tadpoles are at least partly vegetarian. None of these animals contribute obviously to man's economic system. They are rarely, if ever, truly hunted "for sport". As food, they are exploited occasionally as gourmet delicacies—as frogs-legs, turtle soup and turtle and rattlesnake "steak". Some are collected for

[1]Solicited by the Editor

the pet trade, but the majority of specimens sold in Canada are imported from the United States and elsewhere and local populations are rarely exploited. Universities and research organizations use them (particularly frogs, and to a lesser extent turtles, mudpuppies and others) for demonstrating vertebrate structure, physiology and embryology and for experimental studies, but as in the case of pet stock, probably the majority of this material is imported alive or preserved from United States. In terms of their beneficial role to the agriculturalist through the numbers of harmful rodents or insects pests consumed, they doubtless merit some protection although Canadian estimates of dollars and cents worth are not available.

In terms of direct harmful effects, there are only three poisonous species—all rattlesnakes—which occur only in portions of southern Ontario, western Saskatchewan, Alberta and B.C. A restricted population may occur in southeastern Quebec as well (see below) but this is unconfirmed. Although potent, these snakes rarely cause a fatality—and when they do it is usually through the carlessness of the eventual victim. Effective antivenins are available in all areas where rattlesnakes are known to occur.

Little is known of the rôle reptiles or amphibians may play as human disease vectors. Apparently it is generally insignificant. An exception may be in equine encephalitus in the prairies, but their importance has not been fully assessed (Burton, McLintock and Rempel, 1966).

Conservation Problems

Population estimates of amphibians and reptiles are difficult to make, and are usually attempted only through detailed mark and recapture methods. Many species are seasonal in their obvious activity (such as breeding choruses in frogs) and others are secretive throughout the year. Many appear to vary markedly in observable abundance with climatic fluctuations from year to year. At present, estimates of numbers are not available for any Canadian populations—and in some cases even sightings of a rare species have not been made for several years. Canada has few professional herpetologists and the only slightly greater numbers of competent amateurs often do not keep field records, are not consistently active in critical areas (or not active in the field at all—for many are solely keepers of pet stock rather than naturalists) or do not communicate nor publish observations. Anyone with observations of a rare species is urged to write the author so that, in time, we will accumulate a file on the current status of each species. Collections of such species should not be made unless one is fairly certain that such collections will not lower breeding stock to a level at which the species cannot survive in the area. Collections of rare species are usually best left to professionals, where such collections contribute to a specific research program, and the effect on the population is considered.

In general, however, the main danger to rare amphibians and reptiles in Canada is not posed by collection or destruction of individuals. An exception may be in the case of large snakes, which are often bludgeoned to death on sight in the erroneous belief that they are poisonous, or because someone just doesn't like snakes of any kind. Highspeed highways, where they cross traditional routes to breeding grounds (amphibians), egg-laying sites (turtles) or hibernation dens (snakes) often take a large toll, but the populations' ability to adjust to this loss is at present unknown. Even rare species, in terms of total distribution, are often locally abundant, and their real danger is destruction of habitat. Drainage, ever-expanding suburbias and other land use and modification are usually irreversible and complete in their effects. Fortunately, our National and Provincial parks provide areas of habitat conservation in critical areas for the preservation of many rare forms, and some private areas (notably Long Point in southern Ontario) serve the same function. An increasing habitat-conservation philosophy among natural history societies leading to creation of additional sanctuaries provides hope for other species.

In Canada, only one organization exists concerned wholly with the protection of these classes of vertebrates—the Canadian Amphibian and Reptile Conservation Society. They may be contacted through Miss Barbara Froom, 8 Preston Place, Toronto 12, Ontario, or Mr. Craig Campbell, 188 Lester Street, Apt. 7B, Waterloo, Ontario.

Annotated List of Endangered Species

In this list, I have adopted a fairly liberal approach in considering what is an endangered form. As mentioned above the primary concern in Canada is with northern or relict populations of otherwise usually widespread species, and so I have included isolated populations of species, which are not only abundant in the United States, but may be also abundant in other parts of Canada. In all cases the particular population endangered is stressed. For example, the Eastern Gray Tree Frog, *Hyla versicolor,* is included on this list despite the fact that it is abundant in parts of southern Quebec, all of southern Ontario and southeastern Manitoba. However, an important relict population in New Brunswick, isolated by 150 miles from the continuous range of the species, is in very real danger of extinction. This population is thought to be the only surviving remnant of a former extensive range in the Martimes during a warmer period, and therefore is of great interest.

Because of this general approach subspecies are included, and it is worth noting that Canada has 110 forms of amphibians and reptiles (monotypic species plus each subspecies of polytypic species) of which 29 are here considered rare or endangered.

This is a provisional list, and the choices represent my own decisions as to what is rare or endangered. For example I have not included Fowler's Toad, *Bufo woodhousei fowleri* (for another viewpoint see Campbell 1969b), but have included the Spotted Turtle, *Clemmys guttata,* another species with a restricted range in southern Ontario. The reason for this is that I think this toad can probably hold its own as long as some natural habitat exists and it has a high reproductive rate. The Spotted Turtle is apparently declining in numbers, has a much lower reproductive rate and is probably narrower in its habitat preference and therefore should be considered endangered. Of course any and all of our species may be endangered in time unless we exercise constant vigilance against the "improvements" on at least some natural areas, including park areas. The forms listed may be only considered as the most likely to disappear first—some may already be lost. If what we are interested in is *natural* populations, then sections of natural habitat must be protected as a whole, *before* a form is lost.Reintroductions from some other region after a species has disappeared from the original area may ease our collective conscience but possibly it never duplicates the original population. In fact these "reintroductions"—unless economically desirable as a tourist promotion, might just as well be left where found or in zoos. Any introductions of any type of amphibians and reptiles should be carefully recorded and the information placed on file preferably with *both* the National Museum of Natural Sciences and the Canadian Amphibian and Reptile Conservation Society.

In documenting the species list I have used the Canadian Check list of Logier and Toner (1961) as my basis for comments on distribution generally cited only references published since that publication or omitted by it.

TAILED FROG. *Ascaphus truei.* This species is recorded from several localities in southern British Columbia but its narrow habitat tolerance—it requires cold mountain streams—makes it especially vulnerable to habitat changes. Logging along such streams which results in loss of stream shade and thus allows water temperatures to rise could cause local exterminations or drastic reductions in numbers. Several suitable areas of habitat should be protected; at least one exists already in Manning Provincial Park.

Blanchard's Cricket Frog. *Acris crepitans blanchardi.* This form is known only, in Ontario, from Point Pelee National Park and Pelee Is-

land. The existing records are based on only a few specimens and there are few recent observations of it. However, this may be because of its small size and the lack of a search for it during its late spring breeding season in either area. Presumably its prospects for survival in both areas are good, but the breeding sites should be known and conserved.

EASTERN GRAY TREEFROG. *Hyla versicolor*. Although this species is abundant in southern Ontario, portions of southern Quebec, and southeastern Manitoba, there is an endangered relict population in southern New Brunswick. In this province it has been recorded only from the Nashwaak River valley near Fredericton (taken in 1934; but searches in 1953 and 1954 failed to reveal it), and across the St. John River from Fredericton (Bleakney 1958: 31) where it occurs in apparently low numbers. This population may be threatened by human use of the land for housing; if indeed it still exists. It is separated by 150 miles from the continuous range of the species which ends in southern Maine (Bleakney 1958: 31). This colony should be protected.

PACIFIC GIANT SALAMANDER. *Dicamptodon ensatus*. A few localities are known for this species in the extreme southwestern portion of mainland British Columbia. It breeds in rapidly running streams. A portion of its range should be protected.

SMALL-MOUTHED SALAMANDER. *Ambystoma texanum*. This salamander has been recorded, in Ontario, only from Pelee Island. There its survival prospects are good at present, though only six specimens have been recorded (Cook 1964, Uzzell 1962). Any extensive habitat changes on the island would endanger it.

EASTERN TIGER SALAMANDER. *Ambystoma tigrinum tigrinum*. Although the western subspecies are abundant in Manitoba, Saskatchewan and Alberta and also occur in B.C., the eastern race has been only recorded once in Ontario at Point Pelee by P. A. Taverner on October 2, 1915 (Logier 1925). Recent attempts to confirm the existance of this species in the Park by the author, Joyce Cook, Bill Wyett and Craig Campbell in 1967-69 have proved unsuccessful. It is possible that it no longer exists in the area.

NORTHERN DUSKY SALAMANDER. *Desmognathus fuscous fuscus*.. In Ontario, a single record exists "opposite Buffalo, New York." It is unknown if this population still exists. The species occurs fairly abundantly in southern Quebec and southern New Brunswick.

NORTHERN SPRING SALAMANDER. *Gyrinophilus porphyriticus porphyriticus* As in the above species, there is an Ontario record for "opposite Buffalo, New York." One additional Ontario locality, a larva said to have been collected at Ottawa in 1934, has failed to be validated by extensive collecting in this area and may have been in error. In Quebec, it has been recorded several times in the eastern townships and apparently is surviving well in agricultural areas there.

NORTHERN RED SALAMANDER. *Pseudotriton ruber ruber*. In Ontario, this salamander has been recorded from Dunchurch near Parry Sound on the basis of a single specimen taken in 1946 (McCoy and Durden 1965: 156). This locality is some 200 airline miles from the range of the species in southern New York and northern Pennsylvania. There is a possibility that it was brought to the area by bait fishermen as the species is often used for this purpose within its range (Barker 1964: 195; Campbell (1969a). Campbell (1969a) comments on the possibility of other valid records, and (1969b) states positively that there are two records.

SPOTTED TURTLE. *Clemmys guttata*. Although often recorded from southern Ontario in the past, it may be declining in numbers. Once recorded as common at Point Pelee, for example, it is now apparently rare (Patch, 1919; Logier 1925; PC: Bill Wyett; Campbell 1969b). Reasons for this apparent decline are unknown, but habitat changes are indicated (see Campbell 1969b).

NORTHWESTERN POND TURTLE. *Clemmys marmorata marmorata*. In British Columbia this species is known only from two specimens, one taken near Burnaby Lake, Vancouver in 1933 and one from the Jericho Golf Links in 1936 (Carl 1944: 43). The continued existance of the species in British Columbia is questionable even if these specimens represent natural populations rather than introductions.

BLANDING'S TURTLE. *Emydoidea blandingi*. In Nova Scotia a small relict but apparently thriving population exists in the southwestern portion of the province in the area of Lake Kejimkujik (Bleakney 1958, 1963), now at least partly within the recently formed Kejimkujik National Park. Although absent from New Brunswick, the species is fairly common in southern Ontario and adjacent Quebec.

EASTERN SPINY SOFTSHELL *Trionyx spinifer spinifer*. This species is rare in Quebec Province. Recent records are from Ile Perrot at the junction of the Ottawa and St. Lawrence rivers and from the Pike River where it enters Mississquoi Bay of Lake Champlain (Lovrity and Denman 1964). An old record from Ottawa is validated by a recent sight record upriver on the Ottawa River. This secretive species is probably rare in these areas. It is apparently more common in southern Ontario.

PIGMY HORNED LIZARD *Phrynosoma douglassi douglassi*. In southern British Columbia, only two specimens have been taken at Osoyoos (Carl, 1944). Nothing is known of the current status of this dry region lizard, and it may no longer occur in the area.

(A related form, *P. d. brevirostre*, the Eastern Short-horned Lizard, occurs in southern Alberta and southwestern Saskatchewan. It is apparently of scattered occurrence and quite difficult to find, making assessment of its status impossible at present. It probably is holding its own.)

NORTHERN PRAIRIE SKINK. *Eumeces septentrionalis septentrionalis*. A relict population, disjunct by 120 miles from the nearest records in Minnesota, occurs in the area of the Spruce Woods Forest Reserve east of Brandon (Cook 1964). Much of this area is an army artillery range (for Camp Shilo) and the extreme eastern part is a newly created provincial park. Its status is currently under study by Errol Bredin.

QUEEN SNAKE. *Regina septemvittata*. This species is restricted in Ontario to the southern part of the province and apparently is of scattered occurrence but possibly fairly common where it occurs. It is a stream and river edge snake and could be in danger due to this restricted habitat. Recent observations by W. W. Judd, B. McBride and Craig Campbell confirm its continued existance in the province (Judd 1955, 1962; Campbell 1969b). Some of the known localities should be protected.

LAKE ERIE WATER SNAKE. *Natrix sipedon insularum*. The entire range of this subspecies is the chain of islands in Lake Erie of which Pelee Island is one. It is characteristically a grey snake with typical *Natrix sipedon* banding reduced or absent, an adaptation for the rocky shorelines of the islands it inhabits. Because of its restricted habitat and vulnerability to persecution it could be endangered, but at the moment it is apparently holding its own, although severely persecuted on the U.S. islands (Conant and Clay 1963: 183).

BUTLER'S GARTER SNAKE. *Thamnophis butleri*. In southern Ontario this small snake has been collected only from Newberry and Rondeau Park areas where it may be locally abundant. Because of scattered occurrence same steps should be taken to preserve at least one area of its occurrence. At Rondeau it apparently does not occur within the park limits.

NORTHERN RIBBON SNAKE. *Thamnophis sauritus septentrionalis*. A relict population in southwestern Nova Scotia (Bleakney 1958) apparently exists in small numbers. As with the Blanding's turtle a portion of its range may be protected by Kedjimkujik National Park. This form is fairly abundant in Southern Ontario.

Eastern Hognose Snake. *Heterodon platyrhinos*. This snake occurs in southern Ontario as far east as Algonquin Park in primarily sandy areas. It may be declining in numbers, and is often killed because of its size and characteristic bluff attack when disturbed. Further study of its present distribution and numbers is needed, as there is evidence that it no longer occurs at Point Pelee and Rondeau where it was once recorded (Campbell 1969b).

WESTERN HOGNOSE SNAKE. *Heterodon nasicus nasicus*. This western form is of scattered occurrence in southwestern Manitoba, southwestern Saskatchewan and southern Alberta. It is apparently rare, although its relative secretiveness contributes to this conclusion. Populations in the Spruce Woods Forest Reserve in Manitoba are afforded partial protection by their location (see remarks under *Eumeces septentrionalis*).

[BLACK RACER. *Coluber constrictor constrictor*. This subspecies has often been reported from the Maritime Provinces (see Bleakney 1958; Logier and Toner 1961) but it has been suggested by Cook (1967: 49-50) that its actual occurrence may be a myth. No specimens with data exist from the Maritimes and it is probably best dropped from the Canadian species list until proof of its occurrence can be obtained.]

BLUE RACER. *Coluber constrictor foxi*. Recorded from Pelee Island, Point Pelee and Grand Bend, this subspecies may never have been abundant in southern Ontario and certainly is now rare. Until positive verification of its continued existence in Ontario can be obtained no protective measurements can be taken. Point Pelee populations have apparently disappeared and its continued existence on Pelee Island is doubtful but it may still occur in the Grand Bend area.

EASTERN YELLOW-BELLIED RACER. *Coluber constrictor flaviventris*. This form has been recorded in Saskatchewan only from the Val Marie area, on the basis of two specimens (Mahr and Beck 1964). It is apparently rare and restricted to this area which is a remote and relatively undisturbed ranching region.

EASTERN FOX SNAKE. *Elaphe vulpina gloydi*. The entire distribution of this subspecies is confined to areas adjacent to Lake Erie and Lake Huron in southern Ontario and the United States (see Map 124 in Conant 1958) and Canada has the largest part of this range. Populations still exist at Point Pelee, Rondeau and Long Point where they have some measure of protection, and additional colonies apparently still exist along Lake Huron. Unfortunately this species is often killed because of its large size and the erroneous belief that it is a "copperhead." It also is a favorite with reptile "keepers." Total protection should be given to it, at least until population estimates can be obtained. A study of this sort is currently in progress at Point Pelee National Park.

BLACK RAT SNAKE. *Elaphe obsoleta obsoleta*. This species is apparently now rare in southwestern Ontario but is still present in fair numbers in central Ontario in the Rideau Lakes region. Both highway traffic and the anti-snake attitude take their toll of this large snake. A protected area should be set aside in the Rideau Lakes region.

PACIFIC GOPHER SNAKE. *Pituophis melanoleucus catenifer*. Only two records of this subspecies are known in B.C.: one prior to 1866 from Sumas and the other in 1947 from Galiano Island (Carl 1963). East of the coast range a related subspecies (*P. m. deserticola*) is fairly common and another occurs in southern Alberta and Saskatchewan (*P. m. sayi*).

SHARP-TAILED SNAKE. *Contia tenuis*. Until recently this species was recorded in British Columbia only from North Pender Island and Vancouver Island. However, it has been taken recently at McGillivray Lake near Chase, in the Fraser River drainage, 235 mi. NE of North Pender Island (Tanner 1967: 323) and this may indicate a more extensive range than previously realized. Until more data are available no conservation measures can be advocated.

TIMBER RATTLESNAKE. *Crotalus horridus horridus*. Within historic times this large venomous snake probably ranged from the Niagara Gorge region of Welland County, Ontario northward along the limestone outcropping to Manitoulin District (Logier and Toner 1961: 80). It was last positively recorded from the Niagara Gorge in 1941 or possibly 1942 and may now be extirpated from all of Ontario. Rumors of specimens seen in extreme southern Quebec are unconfirmed, as are more recent Ontario records (Campbell 1969b) but these may yet be validated.

EASTERN MASSASAUGA. *Sistrurus catenatus catenatus*. This small rattlesnake ranges in southern Ontario from Lake Erie northward to French River, southeastern Sudbury District and Manitoulin District; eastward at least to the Muskoka Lakes (Logier and Toner 1961: 79). Most Lake Erie colonies seem to be reduced or extirpated, although they do still survive near Port Colborne and perhaps elsewhere. The best colonies are probably in the Bruce Peninsula and Georgian Bay areas. This species is heavily persecuted as it has caused at least two deaths in Ontario in the last 15 years. Its venom, though potent, is not produced in large amounts. Its usefulness as a rodent exterminator could be worth the slight hazard its presence poses—particularly if the public was educated to exercise proper care in its habitat, and heeded the caution never to handle it.

Acknowledgements

I have been fortunate in talking or corresponding with perhaps the majority of people actively interested in Canadian herpetology over the past ten years and to all I acknowledge my indebtedness. Among those who have contributed opinions and/or information used in this list are the following: M. A. Adamson, the late A. E. Allin, F. G. Bard, J. S. Bleakney, H. Beck, J. Bogart, E. Bredin, C. A. Campbell, K. Campbell, G. C. Carl, the late R. Connell, I. McT. Cowan, S. Criddle, E. J. Crossman, F. Darroch, N. S. Denman, C. Douglas, R. Y. Edwards, M. G. Foster, Miss B. Froom, J. Gilhen, P. Gregory, S. W. Gorham, A. F. Helmsley, M. A. Hopkinson, J. Kenney, R. King, B. Krug, J. Lane, V. Lewin, R. V. Lindsay, E. B. S. Logier, J. Lovrity, B. McBride, J. A. McLeod, R. C. Mills, R. W. Nero, C. B. Powell, W. B. Preston, W. B. Scott, D. Stirling, K. W. Stewart, R. W. Sutton, G. C. Toner, R. D. Ussher, W. R. Wyett, F. Zemlicka.

Literature Cited

Barker, Will. 1964. Familiar Reptiles and Amphibians of America. Harper and Row. New York, Evanston and London. 220 pp.

Bleakney, J. Sherman. 1958. A zoogeographical study of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 155: 1-119.

Bleakney, J. Sherman. 1963. Notes on the distribution and life histories of Turtles in Nova Scotia. The Canadian Field-Naturalist 77(2): 67-76.

Campbell, Craig. 1969a. Herptile-hunting on holiday — Part 1 (Amphibians). Canadian Amphibian and Reptile Conservation Society Bulletin 7(4): 1-3.

Campbell, C. A. 1969b. "Who cares for the Fowler's Toad?" The Ontario Naturalist 1969(4) December: 24-27.

Carl, G. Clifford. 1944. The reptiles of British Columbia. British Columbia Provincial Museum Handbook No. 3. pp. 1-60.

Carl, G. Clifford. 1959. The Amphibians of British Columbia. British Columbia Provincial Museum Handbook No. 2: pp. 1-62.

Carl, G. Clifford. 1963. A coastal record of the Gopher Snake (*Pituophis*). The Canadian Field-Naturalist 77(4): 178.

Conant, Roger. 1958. A Field Guide to Reptiles and Amphibians of the United States and Canada East of the 100th Meridian. Houghton Mifflin Company, Boston. pp. i-xv, 1-366.

Conant Roger and **William M. Clay.** 1963. A Reassessment of the taxonomic status of the Lake Erie Water Snake. Herpetologia 19(3): 179-184.

Cook, Francis R. 1964. Additional specimens of the Smallmouthed Salamander from Pelee Island, Ontario. The Canadian Field-Naturalist 78(3): 201-202.

Cook, Francis R. 1964. The Northern Prairie Skink in Manitoba: a possible relic population. National Museum of Canada, Natural History Papers No. 24: 1-11.

Cook, Francis R. 1967. An analysis of the herpetofauna of Prince Edward Island. National Museum of Canada Bulletin 212: i-vii, 1-60.

Judd, W. W. 1955. Observations on the habitat and food of the Queen Snake, Natrix septemvittata at London, Ontario. The Canadian Field-Naturalist 69(4): 167-168.

Judd, W. W. 1962. Queen Snakes on the Ausable River at Arkona, Ontario. The Cardinal 41: 2.

Logier, E. B. S. 1925. Notes on the herpetology of Point Pelee. The Canadian Field-Naturalist 39(5): 91-95.

Logier, E. B. S. and **G. C. Toner.** 1961. Check list of the amphibians and reptiles of Canada and Alaska. Life Sciences Division, Royal Ontario Museum Contribution 53:1-92.

Lovrity, Joseph and Norris Denman. 1964. An Eastern Spiny Soft-shelled Turtle from Quebec Province. The Canadian Field-Naturalist 78(1): 63-64.

Maher, William J. and W. Harvey Beck. 1964. Two records of the Yellow-bellied Racer in Saskatchewan. The Blue Jay 22(4): 174.

McCoy, C. J. and **C. T. Durden.** 1965. New distribution records of amphibians and reptiles in Eastern Canada. The Canadian Field-Naturalist 79(2): 156-157.

Patch, C. L. 1919. A rattlesnake, melano garter snakes and other reptiles from Point Pelee, Ontario. The Canadian Field-Naturalist 33(3): 60-61.

Tanner, Wilmer W. 1967. *Contia tenuis* Baird and Girard in continental British Columbia, Canada. Herpetologica 23(4): 323.

Uzzell, Thomas M. 1962. The Small-mouthed Salamander, new to the fauna of Canada. The Canadian Field-Naturalist 76(3): 182.

Received January, 1970
Accepted February, 1970

Endangered Canadian Mammals[1]

N. S. NOVAKOWSKI
Staff Specialist on Mammalogy,
Canadian Wildlife Service,
Department of Indian Affairs and Northern Development, Ottawa.

Abstract. A brief survey of the extinct and vanishing mammals of Canada shows twelve species in danger of extinction and three species already extinct by our hand in our brief history in Canada. As the endangered species and those in restricted habitats can be destroyed as much by damage or modification of their environment as by hunting the management and preservation of the habitats in which they live is vital. The critical population status of some of the species is stressed.

The rare and endangered mammals of Canada need to be identified so that the public may become aware that modern man's influence on the environment is significant and that an erosion of wildlife populations and their habitat is occurring. Some once-abundant species are now either rare or extinct, and unique ecosystems have been wholly or partially destroyed. However, rehabilitation of some endangered species is still possible.

The International Union for the Conservation of Nature and Natural Resources has, through its Survival Service Commission, published a Red Data Book on rare and endangered species throughout the world. The Canadian list given in that publication is incomplete and a more definitive work which hopefully will inform the Canadian public is now being written. This paper is intended to summarize that work and to provide a medium by which new information on other species inadvertently omitted can be brought to our attention.

In general, those animals of high economic and recreational value to Canadians are managed carefully for the public good. Those species, generally the larger ungulates or furbearing animals, are specified as game in provincial and territorial game regulations or ordinances. But "economic man" has not yet realized that other mammals also have a significant role in the ecosystem.

The designation of rare or endangered species is a complex matter especially since enough information on populations, taxonomy and distribution of the smaller and/or rarer mammals is lacking. The status and importance of the species listed here have, therefore, been evaluated subjectively.

"Rare" species either occupy an extremely restricted habitat or are low in numbers. "Endangered" species, on the other hand, were once either abundant or generally well distributed throughout Canada and are now being threatened by destruction of the habitat or by deliberate attempts to eliminate them. The bison is a case in point. "Peripheral" species have not been classified because they are distributed on the periphery of Canadian territory and thus may appear rare to Canadians.

1. THE ROOSEVELT ELK, *Cervus canadensis roosevelti* (Merriam).

   The Roosevelt Elk was found on the mainland in southern British Columbia and is now found in limited numbers only on Vancouver Island. It is now protected. This subspecies also is distributed in the states of Washington, Oregon and northern California in limited numbers. However, Canada's population is isolated and vulnerable without complete protection.

2. THE CALIFORNIA BIGHORN, *Ovis canadensis californiana* (Douglas).

   This species, formerly present throughout southern interior British Columbia is now restricted in separate herds—the Chilcotin-Riske Creek group, the Ashnola group, the Vaseaux Lake group in the Okanagan, and smaller groups associated in the same general area which total approximately 1,200 animals. The California bighorn is still hunted legally, and probably also illegally, but attempts are being made

[1]Solicited by the Editor

to create sanctuaries for the species by securing and protecting summer and winter range. Competition for range with cattle is still a problem.

3. THE WOOD BISON, *Bison bison athabascae* (Rhoades).

The wood bison was once numerous numbering in the many thousands particularly in northern Alberta and the southern Mackenzie District of the Northwest Territories. It probably ranged along the Foothills of the Rocky Mountains southward into the United States. Due to hunting, severe climatic factors and hybridization in the last century the wood bison was thought to be extinct. However, a small group in Wood Buffalo Park was identified, isolated and transplanted to its historic range where it is now under protection. A breeding herd to provide further wood bison stock for transplant is now isolated in Elk Island National Park. The total population of this subspecies is now approximately 75 animals.

4. THE NORTHERN KIT FOX. *Vulpes velox hebes* (Merriam).

This species, once common on the Great Central Plains in Manitoba, Saskatchewan and Alberta, is now found only in southern Alberta and southern Saskatchewan. It is extremely limited in number and an increase can only be possible under complete protection, probably in a sanctuary such as a national park. Their status is so critical that if no attempts are made at rehabilitation soon the subspecies will become extinct.

5. THE VANCOUVER ISLAND WOLF. *Canis lupus crassodon* (Hall).

The Vancouver Island wolf is restricted to Vancouver Island in British Columbia. Because of earlier extermination programs and present day expansion of development activities on Vancouver Island, the habitat is becoming continually restricted and numbers are very limited.

6. THE NORTHERN ROCKY MOUNTAIN COUGAR. *Felis concolor missoulensis* (Goldman).

This geographical race was once distributed along the Rocky Mountain chain in the foothills, the Central Great Plains and extending from Alberta to Saskatchewan and Manitoba. This large range was doubtless a result of the many discontinuous series of hills stretching from the foothills into Manitoba, where some of these animals have been taken in the last few decades. Because of continual hunting and poisoning programs, numbers have been diminishing rapidly and the animal is becoming more and more restricted to the isolated areas of the Rocky Mountain chain. It is protected in the national parks of Canada but not elsewhere.

7. THE EASTERN COUGAR. *Felis concolor cougar* (Kerr).

The eastern cougar was once distributed throughout Ontario, Quebec and the Maritime Provinces. It is now very nearly extinct. Authorities in the Province of New Brunswick believe there are three separate groups of the eastern cougar in New Brunswick, and unconfirmed reports seem to indicate that a few might also be found in eastern Quebec, south of the St. Lawrence River. There is no protection for the species.

8. THE BLUE BEAR OR GLACIER BEAR. *Ursus americanus emmonsii* (Dall).

This bear is found in southwest Yukon Territory and in southeast Alaska. It is protected in Alaska by regulations, because the population is within the Glacier Bay National Monument. In the Yukon Territory it is protected and found only in

the Kluane Game Sanctuary. It occurs as a colour phase of the black bear but is considered a separate race. The population although extremely limited has stabilized under protection.

9. BROWN BEAR. *Ursus arctos.*

At least four particular geographic races of the brown bear are extremely rare. At present the taxonomic status of these races is under review and they will be discussed under their common name.

(a) THE BARREN-GROUND GRIZZLY. This race is now found throughout the mainland Northwest Territories, but generally only in the tundra regions and near treeline, where they may grade imperceptibly into the mountain grizzly. The barren-ground grizzly is protected over most of its range by legislation but increased activity by exploration crews poses a new danger to the limited population as undoubtedly bears will be shot supposedly in defence of life or property.

(b) THE LILLOOET GRIZZLY. Originally found in southern interior British Columbia, the Lillooet grizzly was never abundant and because it was subjected to heavy hunting pressure it is now extremely rare and may be extinct.

(c) THE BIG PLAINS GRIZZLY. Originally this race was found in the Central Great Plains area of Alberta, Saskatchewan and Manitoba in those areas that are now the major agricultural areas of Canada. Probably retreated and is now synonymous with the Rocky Mountain grizzly. There are reports that the race still exists in the Swan Hills of Alberta and specimens have been taken from that area for taxonomic studies. The Swan Hills area is presently under permit for oil exploration and legislation to protect this race is required.

(d) THE CHELAN GRIZZLY. This geographic race ranged only in western British Columbia on the mainland and is now found in wilderness areas in small isolated populations. It has been reduced by hunting pressure and may eventually be protected.

10. THE BLACK-FOOTED FERRET. *Mustela nigripes.* (Audubon and Bachman). This interesting species was once common in southern Alberta and southern Saskatchewan and was generally associated with prairie dog colonies. A predator of the prairie dog, the ferret was reduced in numbers as a result of poisoning campaigns to reduce the number of prairie dogs which interfered with ranching operations and cultivation. There are very few records of any black-footed ferret being sighted and the animal may be more common in the United States than in Canada. If so rehabilitation is a possibility.

11. THE NEWFOUNDLAND PINE MARTEN. *Martes americana atrata* (Bangs.)

This species was once found throughout Newfoundland and Anticosti Island. Because of extreme hunting pressure and a reduction in its habitat, the pine marten is now found only in the lower Grand Lake and Gamble Lake areas in Newfoundland. It is difficult to provide protection for such a wide ranging animal but the populations are sufficiently isolated to be secure if only in limited numbers.

12. THE BLACK-TAILED PRAIRIE DOG. *Cynomys ludovicianus ludovicianus* (Ord).

The prairie dog was once common in the Great Central Plains area of southern Saskatchewan and southern Alberta. Their colonial habits made it simple to eradicate them, generally by poisoning. Consequently, only a few live colonies exist in the Frenchman River Valley area of southern Saskatchewan. One of these colonies has been fenced off and is under protection by the Saskatchewan Natural History Society. That colony is east of Val Marie, Saskatchewan in the valley of the Frenchman River.

Extinct Mammals

Extinction, the complete elimination of a species, can occur in many different ways. The most important in geological times are techtonic upheavels, changes in climatic conditions and specialization of species unable to adapt to changing conditions. Man, as a modifier of the environment, can also change the conditions for the existence of a species by habitat destruction or by reducing the number of animals to such a low level that they cannot perpetuate themselves. In Canada, only a few animals have become extinct as a result of man's action.

These are:

(a) THE QUEEN CHARLOTTE ISLANDS CARIBOU. *Rangifer tarandus dawsoni* (Seton).

This race, also called the Dawson caribou, was at one time present but never abundant in the Queen Charlotte Islands of British Columbia. They became extinct about 1935 due to hunting pressure from fishermen who used the various harbourages in the islands.

(b) THE GREAT PLAINS WOLF. *Canis lupus nubilus* (Say).

The Great Plains wolf roamed the Central Great Plains of southern Manitoba, Saskatchewan and Alberta. This subspecies was the "buffalo wolf" which roamed with the vast herds of bison on the Central Great plains. When the bison vanished, the buffalo wolf then preyed on livestock and became an enemy of the rancher. It was gradually eliminated by hunting, trapping and poisoning and became extinct in the 1930's. Intergrades with other subspecies may still exist but this is a very slim hope indeed.

(c) THE NEWFOUNDLAND WOLF. *Canis lupus beothucus* (Allen and Barbour).

The Newfoundland wolf was found throughout Newfoundland and was exterminated by the late 1930's. Settlement and continued persecution over centuries contributed to extinction.

Peripheral to Canada

VIRGINIA OPOSSUM. *Didelphis marsupialis virginiana.*

THOMAS'S BAT. *Myotis lucifugus carissima.*

FRINGED-TAILED BAT. *Myotis thysanodes thysanodes.*

MERRIAM'S MASKED BAT. *Myotis subulatus melanorhinus.*

SAY'S MASKED BAT. *Myotis subulatus subulatus.*

LITTLE CALIFORNIA BAT. *Myotis californicus californicus.*

WESTERN RED BAT. *Lasiurus borealis teliotis.*

LEATHER-WINGED BAT. *Nycticeius humeralis humeralis.*

LARGE BIG-EARED BAT. *Antrozous pallidus cantwelli.*

SOUTHERN SADDLE-BACKED SHREW. *Sorex arcticus laricorum.*

KLAMATH SHREW. *Sorex bendirii bendirii.*

TROWBRIDGE'S SHREW. *Sorex trowbridgii trowbridgii.*

WISCONSIN WATER SHREW. *Sorex palustris hydrobadistes.*

MONTANA SHREW. *Sorex vagrans longiouus.*

SEATTLE MOLE *Neurotrichus gibbsii minor.*

SHOALWATER BAY MOLE. *Scapanus orarius orarius.*

TOWNSEND'S MOLE. *Scapanus townsendii.*

PRAIRIE MOLE. *Scalopus aquaticus machrinus.*

IOWA COUGAR. *Felis concolor schorgeri.*

WISCONSIN GREY FOX. *Urocyon cinereoargenteus ocythous.*

EASTERN GREY FOX. *Urocyon cinereoargenteus cinereoargenteus.*

NORTHERN GREY FOX. *Urocyon cinereoargenteus borealis.*

NORTHERN LONG-TAILED WEASEL. *Mustela frenata spadix.*

PACIFIC WOLVERINE. *Gulo luscus luteus.*

PUGET SOUND SPOTTED SKUNK. *Spilogale gracilis latifrons.*

MCCARLEY'S SPOTTED SKUNK *Spilogale putorius.*

PUGET SOUND STRIPED SKUNK. *Mephitis mephitis spissigrada.*

BROWN MOUNTAIN BEAVER. *Aplodontia rufa rufa.*

YELLOW-BELLIED MARMOT. *Marmota faviventris nosophora.*

WASHINGTON DOUGLAS SQUIRREL. *Tamiasciurus douglasii douglasii.*

BANG'S FLYING SQUIRREL. *Glaucomys sabrinus bangsi.*

TOWNSEND MEADOW MOUSE. *Microtus townsendii townsendii.*

NORTHERN PINE MOUSE. *Microtus penetorum scalopsoides.*

PALLID PYGMY VOLE. *Lagurus curtatus pallidus.*

ALASKA VARYING LEMMING. *Dicrostonvx groenlandicus rubricatus.*

DUSKY HARVEST MOUSE. *Reithrodontomys megalotis megalotis.*

OLIVE-BACKED POCKET MOUSE. *Perognathus fasciatus olivaceagriseus.*

MONTANA KANGAROO RAT. *Dipodomys ordii terrosus.*

MISSISSIPPI VALLEY POCKET GOPHER. *Geomys bursarius bursarius.*

CALIFORNIA PORCUPINE. *Erethizon dorsatum epixanthum.*

WASHINGTON COTTONTAIL. *Sylvilagus nuttallii.*

NEW ENGLAND COTTONTAIL. *Sylvilagus transitionalis.*

WESTERN WHITE-TAILED JACKRABBIT. *Lepus townsendii townsendii.*

EASTERN AMERICAN ELK. *Cervus canadensis canadensis.*

Conclusion

The list has been compiled from scattered records and, no doubt, excludes many authors and important mammals. Marine mammals are not included for they are the responsibility of the federal Department of Fisheries and Forestry. The list is far from complete for a thorough review of all Canadian mammals has yet to be made and, undoubtedly, some species have never been recorded or taxonomically defined. It does, however, point out many mammals which have had little attention.

A few species are extinct. Some species need rehabilitation which can be done with proper management—once the public becomes aware of, and is sufficiently concerned about, the necessity for it. With many of the larger, more spectacular species, it is relatively easy to stir the imagination of the public. But with many of the smaller species, new kinds of motivations are required. Ecosystem management is necessary before they can be secure. And we will all—the conservationists and the public at large—have to face the fact that many of the smaller species may be vanishing because of uncontrolled destruction of the habitat.

Such northern mammals as the polar bear, barren-ground caribou and muskoxen have been classed by the Canadian government as "in danger of extinction". However, they are hunted for food and pelts and it would be inappropriate to arouse public sentiment at this time unless, of course, their extinction was imminent. In any case the population status of these mammals is being continually assessed.

A complete re-evaluation of our rare and endangered mammals is now being made so that a more complete list can be given to the Survival Service Commission of the International Union for the Conservation of Nature and Natural Resources.

References Used

Anonymous. Proceedings of the First International Scientific Meeting of the Polar Bear. Fairbanks, Alaska. September 1965. Published by U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, and the University of Alaska.

Anonymous. Rare and endangered Fish and Wildlife of the United States. Bureau of Sport Fisheries and Wildlife (Resources Publication 34). Washington, D.C. 1966.

Allen, G. M., and **Barbour, Thomas.** 1937. The Newfoundland wolf. Journal of Mammalogy 18:229-234, 1 figure.

Allen, Glover M. 1942. Extinct and vanishing mammals of the Western Hemisphere. American Committee for International Wildlife Protection, Special Publication II.

Allen, Joel Asaph. 1909. The white bear of southwestern British Columbia. Bulletin of the American Museum of Natural History 26:233-238, figs. 1-4.

Anderson, R. M. 1946. Catalogue of Canadian recent mammals. National Museum of Canada. Bulletin No. 102(31).

Anderson, R. M. 1948. A survey of the Canadian mammals of the north. Annual Report of the Province of Quebec Association for the Protection of Fish and Game. 89:9-17.

Anderson, R. M. 1939. The present status and distribution of the big game mammals of Canada. Trans. 3rd North Amer. Wildlife Conference, Baltimore, 1938, p.p. 390-406, maps.

Anthony, H. E. 1928. Field Book of North American Mammals. Putnam's Sons, New York-London.

Asdell, S. A. 1946. Patterns of Mammalian Reproduction. Comstock Publishing C., Inc. New York.

Audubon, John James, and **John Bachman.** 1849. Quadrupeds of North America. Vol. II. Lockwood, New York.

Bailey, Vernon. 1935. A new name for the Rocky Mountain elk. Proceedings of the Biological Society of Washington 48:187-189.

Bailey, Vernon. 1936. The mammals and life zones of Oregon. North Amer. Fauna, no. 55, 416 pp., 52 pls., map.

Banfield, A. W. F. 1961. A revision of the reindeer and caribou, Genus *Rangifer*. National Museum of Canada Bulletin No. 177(66).

Banfield, A. W. F.; and N. S. Novakowski. 1960. The survival of the wood bison (*Bison bison athabascae* Rhoads) in the Northwest Territories, National Museum of Canada Natural History Papers, No. 8: 1-6.

Bangs, O. 1897. Preliminary description of the Newfoundland marten. American Naturalist 31: 161-162.

Buechner, H. K. 1960. The bighorn sheep in the United States, its past, present, and future. Wildlife Monographs No. 4. Publication of the Wildlife Society.

Cowan, Ian McTaggart. 1939. The vertebrate fauna of the Peace River district of British Columbia. Occas. Papers Brit. Col. Prov. Mus., no. 1, 102 pp., 5 pls.

Cowan, Ian McTaggart. 1940. Distribution and variation in the native sheep of North America. American Midland Naturalist 24:505-580, 5 figs.

Cowan, I. M., and **C. J. Guiget.** 1965. The Mammals of British Columbia. Third Edition (revised). British Columbia Provincial Museum. No. 11. Victoria.

Dunbar, M. J. 1948. Caribou in the Ungava. Annual Report of the Province of Quebec Association for the Protection of Fish and Game. 89:18-19.

Fisher, James; Simon, Noel; and Jack Vincent. 1969. Wildlife in Danger, Viking Press, New York. 368 pp.

Fryxell, F. M. 1928. The former range of the bison in the Rocky Mountains. Journal of Mammalogy 9: 129-139.

Fuller, W. A. 1962. The biology and management of the bison of Wood Buffalo National Park. Can. Wildl. Serv. Wildl. Mgt. Bull. Ser. 1, no. 16.

Gabrielson, Ira Noel. 1937. Rare and vanishing species. Amer. Field 127 (16):436.

Garretson, Martin S. 1938. The American bison: The story of its extermination as a wild species and its restoration under federal protection, 254 pp., illustr. New York Zoological Society.

Goldman, Edward A. 1937. The wolves of North America. Journal of Mammalogy 18:37-45.

Hagmeier, E. A. 1958. The Inapplicability of the subspecies concept in North American marten. Systematic Zoology. 7(1).

Hagmeier, Edwin M. 1956. Distribution of marten and fisher in North America. Canadian Field-Naturalist 70(4): 149-168.

Hagmeier, Edwin M. 1961. Variation and relationships in North American marten. Canadian Field-Naturalist 75(3):122-138.

Hall, E. Raymond. 1932. Remarks on the affinities of the mammalian fauna of Vancouver Island, British Columbia, with descriptions of new subspecies. University of California Publications in Zoology 38: 415-423.

Hall, E. Raymond, and **Keith R. Kelson.** The Mammals of North America. Ronald Press, New York, 1959.

Harington, C. R. 1964. Polar Bears and their present status. Canadian Audubon Magazine. Jan.-Feb. 1964.

Harper, Francis. 1925. The wood buffalo and the proposed introduction of plains buffalo. Canadian Field-Naturalist 39:45.

Hollister, N. 1916. A systematic account of the prairie-dogs. North American Fauna. No. 40.

Hornaday, William T. 1905. A new white bear from British Columbia. 9th Ann. Rept. New York Zool. Soc., pp. 80-86.

Macpherson, A. H. 1965. The barren-ground grizzly bear and its survival in Northern Canada. Canadian Audubon Society, January-February, 1965.

Manning, T. H. 1948. Report on the Caribou of the Ungava Peninsula. Annual Report of the Province of Quebec Association for the Protection of Fish and Game 89:20-21.

Merriam, C. H. 1902. Three new foxes of the kit and desert fox groups. Proceedings of the Biological Society of Washington 15 (73).

Merriam, C. H. 1918. Review of the grizzly and big brown bears of North America. North America Fauna, No. 41. Wash.

Merriam, C. Hart. 1921. Former range of mountain sheep in California. Journal of Mammalogy 2:239.

Novakowski, N. S. and **W. E. Stevens.** Survival of the wood bison in Canada. Forty-fifth Annual Meeting Am. Soc. of Mammalogists. Winnipeg, Man. June 20, 1965.

Palmer, R. S. 1954. The Mammal Guide. Mammals of North America north of Mexico. Doubleday, Garden City, New York.

Pinney, R. 1966. Wildlife in Danger. Duell, Sloan and Pearce. New York.

Rand, A. L. 1933. Notes on the mammals of the interior of western Nova Scotia. Canadian Field-Naturalist 47:41-50.

Rand, A. L. 1948. Mammals of the Eastern Rockies and Western Plains of Canada. National Museum of Canada. No. 108(35).

Raup, H. M. 1933. Range conditions in the Wood Buffalo Park of Western Canada with notes on the history of the wood bison. Spec. Pub. Am. Comm. for Int. Wildlife Protection. Vol. 1, No. 2.

Seton, Ernest Thompson. 1900. *Rangifer dawsoni*: Preliminary description of a new caribou from Queen Charlotte Islands. Ottawa Naturalist 13:260-261.

Simon, N. 1966. Red Data Book, Mammalia. International Union for the Conservation of Nature and Natural Resources.

Soper, J. D. 1941. History, range and home life of the northern bison. Ecological Monographs 11:347-412.

Soper, J. D. 1964. The Mammals of Alberta. Hamly Press, Edmonton, Alberta.

Sugden, Lawson G. 1961. The California big horn in British Columbia. 1-58.

Tener, J. S., and A. W. F. Banfield. A preliminary study of the Ungava caribou. Journal of Mammalogy 39(4):560-573.

Walker, E. P. 1964. Mammals of the world. Vol. II. John Hopkins Press, Baltimore, Maryland.

Wright, B. S. 1960. The return of the cougar. Audubon Magazine 62:262-265, 294-296.

Young, S. P. and E. A. Goldman. 1944. The Wolves of North America. Publ. American Wildlife Institute, Washington, D.C.

Young, S. P. and E. A. Goldman. 1946. The puma, mysterious American cat. American Wildlife Institute. Wash., D.C.

Received January, 1970.

Accepted February, **1970.**

Canada's Endangered Birds[1]

W. Earl Godfrey
Curator of Birds,
National Museum of Natural Sciences, Ottawa.

Abstract. Lists with annotations *Haliaeetus leucocephalus, Pandion haliaetus, Falco mexicanus, Falco peregrinus, Tympanuchus cupido, Grus americana, Numenius borealis,* and the subspecies *Falco columbarius richardsonii* and *Grus canadensis tabida* as avian taxa the status of which is thought to be endangered in Canada.

Man's incredibly destructive and all-consuming population explosion is placing increasingly disastrous pressures on the environment of other animals. His pollution of our land, water, and air and his wholesale destruction of animal habitats are gravely endangering the very existence of many species of animals including man himself. These alarming conditions are worldwide in extent. Here, however, we shall concern ourselves with some Canadian birds that are now, or soon may be, seriously imperiled.

In addition to the species appearing in the subjoined list, there are a number of others whose populations in Canada are so small that their continued existence in this country might be regarded as potentially precarious.

A considerable proportion of these are species that have relatively satisfactory populations and considerable ranges in contiguous United States, with the northern periphery of the range just reaching into extreme southern Ontario. Examples are the Bobwhite, *Colinus virginianus;* Red-bellied Woodpecker, *Centurus carolinus;* Acadian Flycatcher, *Empidonax virescens;* Prothonotary Warbler, *Protonotaria citrea;* Blue-winged Warbler, *Vermivora pinus;* and Hooded Warbler, *Wilsonia citrina.*

In the southern Okanagan Valley, British Columbia, the only Canadian population of Cañon Wrens, *Catherpes mexicanus,* exists precariously. This tiny population was almost, if not quite, wiped out during the severe winter of 1968-69.

On our east coast there is a breeding population of Great Cormorants, *Phalacrocorax carbo.* Although the species is found also in Europe, Asia, Africa, Australia, and southern Greenland, the Canadian population is isolated and does not exceed 3000 individuals and therefore could be open to disaster.

Bald Eagle. *Haliaeetus leucocephalus.* C. L. Broley (1958) found evidence of drastic declines due to pesticide poisoning in Florida populations as early as 1947. Soon Bald Eagle populations over much of eastern North America began dropping rapidly and the trend continues. Fairly good numbers remain in British Columbia, Alaska, and the forested parts of the prairie provinces but because of the insidious nature of pesticide poisoning there is no certainty that this state of affairs will continue.

Osprey. *Pandion haliaetus.* This picturesque bird feeds on fishes which it catches by means of spectacular plunges. It is drastically declining in number over much of its range, although it apparently is still holding its own in others. R. T. Peterson (1969) recently published some of the alarming facts concerning its decline. Again the evidence is that pesticides are the cause.

Prairie Falcon. *Falco mexicanus.* R. W. Fyfe et al (1969) have noted a 34 per cent reduction in the occupancy of territories in the Canadian part of its range during the past ten years. They observed some local decreases in hatching success and a very significant reduction in eggshell thickness, thus indicating pesticides as the cause of the trouble. Because of its restricted range, this falcon of the western prairies is more susceptible to total disaster than species of broader distribution.

Peregrine Falcon. *Falco peregrinus anatum.* G. Harper Hall (1955) published a delightful account of the Peregrine Falcons that nested for some years on the Sun Life Building in the heart of Montreal. As he studied them he never failed to marvel at the speed and power of these mag-

[1]Solicited by the Editor

nificent birds which seemingly were so ideally equipped to cope with their environment.

Although they appeared to be in the best of health, these birds were, in reality, sick. Indeed, without realizing it, Hall presented one of the earliest records of certain aberrant behavior which we now know to be symptomatic of birds carrying high residues of the chlorinated hydrocarbons such as DDT.

That was in 1949. Today the Peregrines are long since gone from the Sun Life Building and their race *F. p. anatum* has completely disappeared from half a continent with only a pitiful few pairs left on the northwest periphery of their once vast range to keep them from extinction!

Nor should we feel complacent about the fact that fair populations of other races of the species still exist in the North American Arctic and on the northwest coast. In less than twenty years the entire population of half a continent slipped into oblivion almost before we realized that anything was wrong.

RICHARDSON'S PIGEON HAWK. *Falco columbarius richardsonii.* This race of the Pigeon Hawk is limited to the prairies and its numbers should be watched carefully.

GREATER PRAIRIE CHICKEN. *Tympanuchus cupido pinnatus.* Although this grouse once ranged over considerable parts of southern Alberta, Saskatchewan, and Manitoba (as well as small areas in Ontario), it seems to have disappeared completely from the prairie provinces. The only remaining population in Canada is on Manitoulin Island. Even there, that small population is hybridizing extensively with its near relative, the Sharp-tailed Grouse. It is quite possible that no *pure* Prairie Chickens remain in Canada today. Although the species was hunted in the prairie provinces, this is unlikely to have caused its extirpation there. Destruction of its habitat by grazing and agriculture seem to be the main factors in its decline.

WHOOPING CRANE. *Grus americana.* This large, picturesque bird formerly nested widely in the western provinces. It was inevitable that such a tempting target could not be resisted by the early settlers who shot many between 1865 and 1900. This, combined with the wholesale destruction of its marshy habitat, soon brought it to the brink of extinction. Its only remaining nesting grounds in the wild are in Wood Buffalo Park, N.W.T. In 1941, only 23 living Whooping Cranes were left. Wise management had increased its numbers to 68 individuals (including 18 in captivity) by January, 1969.

GREATER SANDHILL CRANE. *Grus canadensis tabida.* Numbers of this large subspecies of the Sandhill Crane, which nests along the southern edge of the species' range, have been severely decimated. Shooting, especially by prairie pioneers, and destruction of its habitat where it conflicted with agricultural interests, are important factors in its decrease.

ESKIMO CURLEW. *Numenius borealis.* Formerly abundant, this shorebird concentrated in large flocks in its journeys between its breeding range in Mackenzie and its wintering grounds in South America. Such concentrations led to its downfall for it was slaughtered mercilessly by gunners. Its numbers nose-dived just prior to 1888-1890 and despite subsequent protection by law it never recovered. For many years it has remained almost extinct. The location of the nesting grounds of the few that survive is unkown.

IPSWICH SPARROW. *Passerculus princeps.* The Ipswich Sparrow has the smallest breeding range of all Canadian birds. Its nesting grounds are restricted to tiny Sable Island, about 90 miles off the coast of Nova Scotia. McLaren (1968) has estimated its total breeding population at 4000 individuals.

In the past, this little sparrow has braved many dangers. Its yearly flight to its tiny island breeding grounds demands accurate navigation and strong flight to keep it on course against the strong winds that prevail there.

There have been various man-made threats to its existence. Man-introduced rabbits once depleted the vegetation of the island. Rats, which reached the island from shipwrecks, multiplied to such an extent that they almost wiped out the rabbits and must have posed a serious threat to the sparrow. Man then brought cats to the island and they annihilated the rats and re-

maining rabbits. Soon the cats became so numerous and destructive that dogs were taken to the island and they, aided by guns in the lightkeeper's hand, finally disposed of the cats. The Ipswich Sparrow managed to persist through all these perils.

Perhaps the greatest threat of all is still to come. Sandy Sable Island is very low and sea level there has been rising at about half an inch per century. If that trend continues, the island home of the Ipswich Sparrow will eventually be submerged (Cameron 1965).

Much more information is needed on pesticide levels in such birds as the loons, grebes, petrels, shearwaters, gannets, cormorants, herons, gulls, alcids, and kingfishers. Many of these are fisheaters at the top of long food chains and such birds are therefore the ones most likely to be in serious trouble.

Literature Cited

Broley, C. L. 1958. The Plight of the American Bald Eaple. Audubon Magazine 60(4): 162-163.

Cameron, H. L. 1965. The Shifting Sands of Sable Island. The Geographical Review 55(4): 463-476.

Fyfe, R. W., J. Campbell, B. Hayson and **K. Hodson.** 1969. Regional Population Declines and Organchlorine Insecticides in Canadian Prairie Falcons. Canadian Field-Naturalist 83(3): 191-200.

Hall, G. Harper. 1955. Great Moments in Action: The Story of the Sun Life Falcons. Mercury Press, Montreal. 1-37.

McLaren, Ian A. 1968. Censuses of the Ipswich Sparrow on Sable Island. Canadian Field-Naturalist 82(2): 148-150.

Peterson, R. T. 1969. The Osprey, Endangered World Citizen. The National Geographic Magazine 136(1): 52-67.

Received January, 1970
Accepted January, 1970

Changes in the Bird Fauna of the Montreal Region, Canada

HENRI OUELLET
Redpath Museum, McGill University, Montreal 110, Canada

Abstract. Important physiographical changes have occurred in the Montreal region since historical times. Changes in bird populations are related to habitat disappearance or constriction. The changes observed in biotic complexes are mostly due to human interference and have given rise to new types of habitats. These modifications have therefore had serious effects on the present bird distribution of the Montreal region: species have disappeared, others have diminished in numbers, others have recently arrived and become established in recent years, and finally others have become more numerous. The author concludes that bird distribution is to a great extent controlled by the availability of suitable habitats.

Résumé. Ce travail consiste en une analyse des changements de la faune avienne dans la région de Montréal. Ces changements, aussi bien dans le nombre que dans l'importance des populations d'oiseaux apparaissent comme étant intimement liés à la suppression ou à la diminution de certains habitats. D'autre part, ces mêmes changements, occasionnés surtout par des influences anthrophiques, ont permis à d'autres habitats de s'instaurer. Il en résulte des modifications importantes chez les nicheurs à l'échelle de la région de Montréal: disparition d'espèces nicheuses, diminution des effectifs de certaines autres, apparition et établissement d'autres, enfin, augmentation du nombre d'individus surtout chez les espèces vivant en terrain à découvert. En terminant, l'auteur conclut que la disponibilité des habitats est un des facteurs essentiels à la dispersion avienne.

Introduction

The Montreal region has undergone important physical modifications since historical times. Although the historic record is sketchy for the most part, recent studies have revealed many changes in the bird distribution of the region.

Dr. Archibald Hall's paper "On the Mammals and Birds of the District of Montreal" (1862) and E. D. Wintle's "The Birds of Montreal" (1869) provide basic information for establishing comparisons between the past bird fauna of the region and the present one; for the latter, some of the data are derived from the Annual Reports of the Province of Quebec Society for the Protection of Birds and from data recorded by the writer during field work since the fall of 1964.

Information concerning changes in bird ranges have been recently provided for Ontario (Snyder, 1957: 26-42), the Great Lakes Region (deVos, 1964: 489-502), and southeastern Canada in general (Godfrey, 1956: 136-138; 1966).

The Montreal Region: physiography and vegetation

The Montreal region as defined here is the area of the St. Lawrence Lowland lying between the Laurentian foothills in the north and the Sutton Mountains in the south, and the western extremity of Lake St. Francis in the southwest and the mouth of the Richelieu River. This flat, low-lying sedimentary plain, from which stand out the eight eruptive Monteregian Hills (620 feet to 1300 feet above sea-level) (Dresser and Denis, 1944) covers roughly 2500 square miles.

From the descriptions provided by the early travellers (Jacques Cartier, Samuel de Champlain, Pierre Boucher, and Peter Kalm), it is evident that the pre-colonial and colonial vegetation consisted primarily of mature deciduous forests, where red oak, *Quercus rubra,* sugar maple, *Acer saccharum,* beech, *Fagus grandifolia,* ashes, *Fraxinus* sp., and elms, *Ulmus* sp., were the dominant species. Coniferous species, such as white pine, *Pinus Strobus,* and white cedar, *Thuja occidentalis,* were found in stands of various sizes, in proper habitats.

Since the establishment of the white man in the region, forested areas have gradually contracted. From recent aerial photographs and field work, I found that forested areas (only those over two acres) occupy now less than 17% of the region and are mainly located on the poorer higher land such as the Monteregian Hills, the rest being farmlands, abandoned farms and vacant lots, sub-urban sectors, reclaimed marshes and bogs, and urban areas.

When changes of that magnitude occur, not only in a limited area, but on nearly half of a continent in a relatively short period of time, great changes in the animal populations occupying these territories are to be expected. This is particularly true of the Montreal region which stands near the northern extremity of this vast disturbed area.

The present bird fauna of the Montreal Region

Two-hundred and ninety-two (292) species of birds have so far been recorded in the Montreal region, of which 149 have been ascertained to breed; among the latter, several have disappeared from the region, and others have become established in recent years. Wintle, in 1896, considered that 114 species were known to nest in the region. Evidently, important changes have occured since in the breeding bird populations of this area. I will comment primarily on those species actually known to breed and those for which there is sufficient evidence supporting the possibility of their nesting in the region, and on the other important changes for which there is a record.

Extirpated Species

The most dramatic disappearance of a species is certainly that of the Passenger Pigeon, *Ectopistes migratorius,* which was known to nest in the Montreal region at least until the middle of the last century (Couper, 1881:21; LeMoine, 1883:231; Rintoul, 1883:242-243). It was observed for the last known time on Mount Royal on 4 June 1891 (Wintle, 1896: 51-2). There is no doubt that the destruction of the extensive mature deciduous forests of the past, along with over-shooting, are responsible to a large extent for the extinction of that species.

The Peregrine Falcon, *Falco peregrinus,* nested in the Montreal area until 1955 (Ann. Rept., P.Q.S.P.B., 1955: 18; Hall, 1955). It has since disappeared completely as a nesting bird, having been seen since on a few occasions only (Ann. Rept. P.Q.S.P.B., 1955-1965; various personal communications). The reasons for its recent decline are on the whole poorly known although the intensive use of pesticides in recent years undoubtedly accounts to a large degree for the present situation in the populated parts of its breeding range (Carter, 1969; Jeffries, 1967; DeCino *et al.,* 1966; Hickey and Anderson, 1968).

The Common Loon, *Gavia immer,* and the Common Raven, *Corvus corax,* probably nested in proper habitats throughout the region before intensive land clearing and settlements came, although neither has been recorded formerly as nesting species. Both are now known to breed in small numbers just a few miles outside the Montreal area. In all probability, the disappearance of these species can be attributed to habitat destruction and pressures from urbanization.

The extirpation of species, which were formerly known to nest in the area, such as the Olive-sided Flycatcher, *Nuttallornis borealis,* Swainson's Thrush, *Hylocichla ustulata* (Wintle, 1896:80; 127-128), and the Saw-whet Owl, *Aegolius acadicus* (Terrill, 1931: 169-174; Ann. Rept. P.Q.S.P.B., 1952:25), to name only a few, may be directly attributed to the disappearance of the coniferous stands that occured sparingly in the primeval deciduous forest.

Range reductions and changes in status

Habitat modifications, being primarily the result of land-clearing, particularly in the fertile floodplain, and urbanization, have modified the distribution patterns of many species of birds and have had effects on their numbers, not only in this region but elsewhere in adjacent areas (Snyder, 1957; deVos, 1964). It is generally difficult to relate these changes to any cause in particular. In some cases however, numerical changes and range changes may be related to particular events and circumstances.

Forest destruction is probably the most important factor in seriously affecting bird populations in this area. It meant important reduction in the range of several species in restricting them to certain areas; therefore a patchy distribution followed in an area through which they were formerly found in a continuous pattern; this also meant a considerable reduction in numbers for many species. The Wood Duck,

Aix sponsa, which was formerly a common species, at least during migrations (Hall, 1862:53; Wintle, 1896:18), became quite rare at least until the late 1950s; it has increased in numbers considerably since (Ann. Rept. P.Q. S.P.B., 1935-1965; author's observations 1964-1968), probably as a result of strict protection measures.

Marsh birds, particularly the Virginia Rail, *Rallus limicola,* Sora, *Porzana carolina,* Green Heron, *Butorides virescens,* Least Bittern, *Ixobrychus exilis,* Long-billed Marsh Wren, *Telmatodytes palustris,* and Swamp Sparrow, *Melospiza georgiana,* have alarmingly diminished in numbers as a result of marsh drainage and reclamation.

The Black-billed Cuckoo, *Coccyzus erythropthalmus,* and the Yellow-billed Cuckoo, *Coccyzus americanus,* have also become much scarcer in recent years (Ann. Rept. P.Q.S.P.B., 1935-1965; author's observations), perhaps as a result of the extensive use of pesticides (Carter, 1969).

The decline in the population of the Cliff Swallow, *Petrochelidon pyrrhonota,* appears to be directly correlated to the increase in numbers of the House Sparrow, *Passer domesticus.* This swallow is now an uncommon species in the region.

Although it was apparently discovered for the first time as a nesting bird in 1936 (Ann. Rept. P.Q.S.P.B., 1935-1936:6), the Wood Thrush, *Hylocichla mustelina,* was perhaps a nesting bird in this area previously (Hall, 1862:51; Wintle, 1882:108). It is now a common nesting species in certain deciduous stands of the region.

The Bluebird, *Sialia sialis,* after the serious crash in its population during the late 1950s and early 1960s, has now become nearly as numerous as it was before (Ann. Rept. P.Q. S.P.B., 1935-1965; author's observations).

Species of open areas and fields of all sorts have nevertheless benefited from the changes brought to the environment by man. These changes have notably resulted in large increases in the population of the Savannah Sparrow, *Passerculus sandwichensis,* Song Sparrow, *Melospiza melodia,* Bobolink, *Dolichonyx oryzivorus,* and Eastern Meadowlark, *Sturnella magna.* The Red-winged Blackbird, *Agelaius phoeniceus,* probably as a result of its facility to adapt itself to new environmental conditions and marginal habitats such as fields, roadsides, pastures, etc., has increased considerably in numbers in spite of major contractions of its former optimal habitat.

Several species have also been affected by habitat changes and are presently found only in a few relatively undisturbed parts of the area during the breeding season, notably: Ruffed Grouse, *Bonasa umbellus,* Brown Creeper, *Certhia familiaris,* Hermit Thrush, *Hylocichla guttata,* Horned Owl, *Bubo virginianus,* Barred Owl, *Strix varia,* Black-throated Green Warbler, *Dendroica virens,* Black-throated Blue Warbler, *Dendroica caerulescens,* Pine Warbler, *Dendroica pinus,* Northern Waterthrush, *Seiurus noveboracensis,* and Slate-colored Junco, *Junco hyemalis.*

Range Expansions

For reasons that are not always obvious and that are in many cases unknown, some birds have extended their breeding range to areas in which they were not known to occur previously. This phenomenon has been recorded on several instances in the Montreal region and the data available at this time permit a general analysis of the situation.

The newly established species have apparently come from three main directions: some have extended their breeding range from the South, but the majority have a western (or more westerly) origin, and finally, a few come from the East. Although there is little pertinent evidence to show that several species are extending their range beyond the Montreal region, there are meaningful data showing that some species have become established here and have progressively become more numerous over a short period of time.

One could easily understand that species of open areas (*i.e.* fields, pastures, abandoned fields, deserted farms, etc.) would have colonized these new habitats after the forest had been

cleared away but it is difficult to explain why at least seven species of waterfowl have become established here as regular breeding species during the last 25 years. Habitat destruction, water pollution and increased pressure from hunting are certainly not factors to encourage colonization of an area by new species. Evidence supporting important range extension and trends has been obtained in Ontario (Snyder, 1957) and in the Great Lakes region (deVos, 1964).

The Mallard, *Anas platyrhynchos,* which was known to Hall (1862:53), Wintle (1896:13), Macoun and Macoun (1909:78), and to local birdwatchers (Ann. Rept. P.Q.S.P.B., 1935-1950) as a more or less numerous migrant, was recorded as nesting for the first time in 1951 (Ann. Rept. P.Q.S.P.B., 1951:19). This western immigrant has since increased considerably in numbers being recorded nesting regularly in suitable habitats, particularly on the small islands in the Lachine Rapids (*fide* C. D. Snow; author's observations) and where suitable habitats occur on the St. Lawrence, Richelieu and Ottawa rivers. It has been recorded as nesting farther east in Quebec (Godfrey, 1966:55) but its population east of Lake St. Peter is negligible.

The Gadwall, *Anas strepera,* another species of probable western origin, was known to breed in Quebec only on Anticosti Island (Ouellet, 1969). Previously it was usually considered as a rare migrant (Ann. Rept. P.Q.S.P.B., 1935-1965; author's observations, 1964-1968), although its numbers seemed to have increased during the last few years. Between 27 May and 21 June 1968, at least eight nests were found on Lake St. Francis (*fide* W. G. Alliston); considering the number of nests found this event cannot be considered as an isolated breeding record, as it may have been on Anticosti Island (Ouellet, 1969).

The Pintail, *Anas acuta,* which is now known to nest in southern Quebec in general (Godfrey, 1966:58), was reported as nesting in the Montreal area for the first time in 1946 (Ann. Rept. P.Q.S.P.B., 1946:17); it is probably a western immigrant. It is now an uncommon summer resident and breeder in this region, particularly on the isolated islands of the St. Lawrence River (*fide* C. D. Snow; author's observations).

The American Widgeon, *Mareca americana,* was considered a rare migratory species of western origin until 1963, when at least two nests were reported in the region (Ann. Rept. P.Q.S.P.B., 1963:20-21). It has since been found in greater numbers; during the nesting season a few nests have been found regularly throughout the region (Ann. Rept. P.Q.S.P.B., 1963-1965; W. G. Alliston, pers. comm.; author's observations).

The Shoveler, *Spatula clypeata,* is another species of western origin which was recorded only occasionally in the region until 1957 when a nest was discovered on Nun's Island (Ann. Rept. P.Q.S.P.B., 1957:17). It is presently known to breed in small numbers at various points in the region as far east as Lake St. Peter (Ann. Rept. P.Q.S.P.B., 1957-1965; *fide* C. D. Snow and W. G. Alliston; author's observations). Although the range of this species east of its center of abundance in the western provinces (Godfrey, 1966:64) is not continuous, there are enough breeding records in eastern Canada (Godfrey, 1966:64), particularly in the Montreal region to show that this species has progressively become more numerous and well established in recent years; a similar trend has been recorded in southern Ontario (deVos, 1964:497).

Another immigrant of possible western origin, the Redhead, *Aythya americana,* has become established as a nesting bird in recent years. It was first reported as nesting on Lake St. Francis in 1961 (Ann. Rept. P.Q.S.P.B., 1961:19; Bull. ornith., 1961, 6 (4):3). It has since increased considerably in numbers and occurs now as far east as Lake St. Peter (*fide* W. C. Alliston; author's observations). The origin of the population breeding in this region is not known with any certainty. This bird which is more or less abundant in the prairies, Alberta, Saskatchewan, and western Manitoba (Godfrey, 1966:66) may have progressively spread into the East in recent years as it was reported to breed in southern Ontario (Baillie, 1946:111-112) and in Michigan (Wood, 1951:69-70).

However, Redheads have been reared and released in New York State where they became established as breeding birds at least on the Montezuma Marsh (Foley *et al.* 1961, *in* deVos, 1964:497). They may have spread from there and became established on Lake St. Francis and Lake St. Peter.

The Ruddy Duck, *Oxyura jamaicensis,* is another species that has probably spread from the prairies, across southern Ontario (deVos, 1964:496), and nested at least once in Quebec, on Lake St. Peter (Godfrey, 1966:81).

The Gray Partridge, *Perdix perdix,* has spread by its own means into the St. Lawrence Lowland in Southwestern Quebec and it is now found in good numbers at least as far east as Drummondville and St. Alexis, Montcalm Co. (Bull. ornith., 1967, 12(5):24), and less frequently as far east as St. Barthélemy (Bull. ornith., 1964, 9(2):2; 1965, 10 (3):5) and St. Joseph de Beauce (Bull. ornith., 1965, 10(3):5). Indeed, several earlier attempts to introduce it elsewhere in the Province have proved to be unsuccessful. Rand (1945:26) has suggested that the birds observed in Quebec in the early 1940s came from Ontario where they had been introduced previously. It is conceivable that this species has invaded the Province from the West by its own means since there are no barriers of any importance to prevent it from extending its range eastward.

The Mourning Dove, *Zenaidura macroura,* which has expanded its range into eastern Ontario recently (Snyder, 1957:32), has apparently moved into southern Quebec around the turn of the present century; the first breeding data were recorded in 1913 (Dionne, 1914: 1-2) and 1922 (Ann. Rept. P.Q.S.P.B., 1941:15). It has since increased in numbers and is now fairly numerous in proper habitats as far east as the Lévis area.

Although little information is available on the present status of the Barn Owl, *Tyto alba,* it seems that it has moved into the southern part of the Province rather recently, having been recorded at L'Assomption and Berthieville (Cayouette, 1947:631), at St. Hubert (Ann. Rept. P.Q.S.P.B., 1961:26), and more recently at Mont Carmel, Kamouraska County, in the spring of 1968 (Rev. René Tanguay *in litt.*).

The Horned Lark, *Eremophila alpestris,* is probably another species that has become established recently in this region; it is not mentioned by Hall (1862) but Wintle (1896:84) found it a "common summer resident". The subspecies *E. a. praticola* breeds now in good numbers in proper habitats throughout the region. It is probably a western immigrant that has progressed eastward and northward after the clearing of the land, probably around 1870; Snyder (1957:30) quoting McIlwraith thinks that it appeared in Ontario about 1868.

The Rough-winged Swallow, *Stelgidopteryx ruficollis,* which was recorded in the Province for the first time in 1947 (*fide* Jacques Normandin) is now found in small numbers throughout the Montreal region (Ann. Rept. P.Q.S.P.B., 1951-1965; author's observations 1965-1968), and at least as far east as Batiscan (*fide* Jacques Normandin), and Kamouraska (*fide* Willie Labrie *in* Bull. ornith., 1968, 13 (4):39).

The Short-billed Marsh Wren, *Cistothorus platensis,* which was found in the region for the first time in 1938 (Ann. Rept. P.Q.S.P.B., 1938-1939:12) has been reported only on a few occasions since.

The Mockingbird, *Mimus polyglottos,* which was first discovered in southern Ontario in 1860 (Morden and Saunders *in* Snyder, 1957:34) has since spread regularly to the northeast, having been found nesting occasionally in the Montreal region (Ann. Rept. P.Q.S.P.B., 1960:27; author's observations; Quebec Nest Record Card Program), and farther east as far as Tadoussac (Godfrey, 1966:292).

The Starling, *Sturnus vulgaris,* appeared for the first time in the Montreal region in the summer of 1922, and a pair was then found breeding at St. Lambert (Terrill, 1924:58). It has since increased tremendously in numbers, although in the early 1930s (Ann. Rept. P.Q.S.P.B., 1943:25) it appeared to be more numerous than it is at the present, at least in winter. It now nests commonly throughout the area, even in the wooded parts.

The Philadelphia Vireo, *Viero philadelphicus,* was apparently not recorded either by Hall (1862) or Wintle (1896); the writer found it nesting on Mount Yamaska in 1965; other summer records indicate that it may also nest sparingly elsewhere in the area: Granby and Rosemere (Bull. ornith., 1961, 6(4):11); Senneville and Harrington (Ann. Rept. P.Q.S.P.B., 1947:20, 1960:30).

The Cerulean Warbler, *Dendroica cerulea* on which the writer has reported earlier (Ouellet, 1966:335-337; 1967:272-274) is probably a recent arrival in the Montreal region.

The House Sparrow, *Passer domesticus,* after its introduction into Quebec City in 1854, and successful nesting there by 1871, was recorded in Montreal as an abundant nesting species in 1882 (Caulfield, 1890:109). It is now an abundant permanent resident, both in the urban and rural environment.

Snyder (1957:35) mentions that the Cowbird, *Molothrus ater,* was not recorded by Fothergill in southern Ontario (Port Hope), between 1817 and 1840; in southwestern Quebec, it was considered to be a "scarce" summer resident by Hall (1862:51) probably in the late 1830s or early 1840s. Wintle (1896:91) found it a "common summer resident". It is at the present a very common summer resident, which occasionally winters.

The Cardinal, *Richmondena cardinalis,* although it has not been recorded positively as nesting in Quebec to date, shows an interesting pattern of northward range expansion. It apparently bred in southern Ontario (Point Pelee) for the first time in 1901 (Snyder, 1957:36) and has spread regularly northeastward since. It was recorded in the Montreal area for the first time in 1942 (Ann. Rept. P.Q.S.P.B., 1942:24) and since 1956, fairly regularly in winter (Ann. Rept. P.Q.S.P.B., 1956-1965; author's observations); it may have nested in Montreal on three occasions (Ann. Rept. P.Q.S.P.B., 1958:38; 1959:30; 1964:37), and once at Rigaud. Definite evidence of breeding is still lacking, but circumstantial evidence (probable old nests, number of birds seen, behaviour) make me believe that the species has probably nested on a few occasions in the region.

The Rufous-sided Towhee, *Pipilo erythrophthalmus,* now a rare summer resident and occasional winter resident, appears to have established itself rather recently in the area; the first regular observations dating from the late 1930s (Ann. Rept. P.Q.S.P.B., 1938-1965) were made in the extreme southwestern part of the Province. I found it in small numbers in 1965 and 1966 as far east as Mont Shefford. It may have a southern or south-western origin.

The Grasshopper Sparrow, *Ammodramus savannarum,* was apparently not recorded in Quebec prior to 1920 when a small colony was discovered at Chambly (Terrill, 1921:115-116). This colony has apparently disappeared since. However, other colonies have been found at several localities and indicate that this sparrow is at least a rare local summer resident. This bird has probably moved into Quebec from southern Ontario where according to Snyder (1957:36) it appears to have increased in numbers since the turn of the century.

Strong circumstantial evidence — a pair carrying food — indicates that the Henslow's Sparrow, *Passerherbulus henslowii,* probably nested at least once in the area (Ann. Rept. P.Q.S.P.B., 1947:21-22), this probably constituting the first breeding record of the species in Quebec. This is not unlikely since several small colonies have been found in the Ottawa area (Godfrey, 1966: 386).

The Field Sparrow, *Spizella pusilla,* which, according to Wintle (1896:101) was a "scarce summer resident", was not recorded by Hall (1862). Although it may have been overlooked by the latter, it probably established itself fairly recently. It is still an uncommon bird and its distribution in the area is still very restricted and incompletely known.

Other range expansions: non-breeding species

Considering the present breeding range and ecological requirements of several species that have been recorded with a certain frequency in the Montreal area since the turn of the present century, it is highly probable that only a few of

these extralimital records will result in the breeding of those species here. However, a northward progression of certain species like the Tufted Titmouse, *Parus bicolor*, (deVos, 1964: 492-493; Snyder, 1957:33) and the Blue-gray Gnatcatcher, *Polioptila caerulea*, (Snyder, 1951:184; author's observations) particularly in the Great Lakes Region, has been recorded in recent years and it is therefore not improbable that these species may eventually establish themselves in the deciduous forests of the region, although to date these two species have been recorded in the area only irregularly during migrations.

The Oregon Junco, *Junco oreganus*, has been reported on several occasions, mostly in winter, during the last 10 years, not only in this region (Ann. Rept. P.Q.S.P.B., 1959-1965; author's observations) but elsewhere in eastern North America, particularly in the New England States (Audubon Field-Notes, 1955-1968). This species may well be in the process of becoming a rare winter resident in the East.

The Evening Grosbeak, *Hesperiphona vespertina*, was unknown in the Province of Quebec before 1890 (Caufield, 1890:109-110; Wintle, 1896:94). An adult male was then collected in mid-winter. It has increased ever since and is now a regular winter resident whose winter populations in Quebec appear to fluctuate markedly from year to year. Being primarily a species of the coniferous and mixedwood forest, this species is not expected to establish itself as a nesting species in this area.

Conclusions

Several species of birds have established themselves in the Montreal area over the last 75 years. Whether it is possible or not to determine exactly when they first became established here is of great interest but of secondary importance. Most of the newly established ones are species of open areas such as fields, pastures, fallow fields, abandoned farms, etc., birds that have generally benefited from the destruction of the primeval deciduous forest.

Forest destruction, marsh drainage, and human activity in general are among the main causes for the extinction or reduction in numbers of several species. Land clearing, farming, farm desertion, and legal protection are on the other hand responsible for the establishment or the increase in numbers of several other species.

The species of open areas that were already here benefited much in occupying new territories and in increasing tremendously their numbers; on the other hand, the newcomers were successful because they have often occupied new niches in the absence of competition: the rapid spread and success of the Gray Partridge, *Perdix perdix*, in southwestern Quebec is a good example of this situation.

Other species yet, such as several species of ducks, have established themselves in this region during the last few years in spite of many external pressures (water pollution, marginal habitats, increased human disturbance, motor boats, etc.).

Some of these have been introduced elsewhere in adjacent areas, and it is possible that they may be colonizing new regions from these points of introduction. Finally, increased human activity in the Montreal region is destroying the last remnants of certain types of habitats (in particular: marshes, mud flats, bogs, etc.) and will cause the disappearance of several species as breeding birds.

Acknowledgments

I wish to extend my thanks to the numerous observers of the Montreal area who contributed significant and unpublished observations, notably: Mr. W. G. Alliston, Mr. C. D. Snow, and Mr. T. W. Thormin. I am also grateful to the following persons who read the manuscript and offered comments: Drs. Austin W. Cameron and D. E. Sergeant, and Mr. Jacques Normandin. Finally, I am most thankful to Dr. W. E. Godfrey of the National Museum of Natural Sciences for having critically read the manuscript and offered several suggestions.

Literature Cited

American Ornithologists' Union. 1957. Check-list of North American Birds. Baltimore, Maryland, U.S.A., The Lord Baltimore Press, Inc.

Baillie, J. L. 1946. The Redhead as a breeding bird of Michigan and Ontario. Wilson Bulletin 58(2): 111-112.

Carter, Luther J. 1969. DDT: the critics attempt to ban its use in Wisconsin. Science 163(3867). 548-551.

Caulfield, F. B. 1890. Notes on a bird new to the Province of Quebec. Can. Rec. Sci. 4(2): 109-111.

Cayouette, Raymond. 1947. Barn Owl in Quebec. The Auk 64(4): 631.

Club des Ornithologues de Québec. 1960-1968. Bulletin Ornithologique, vols. 5-13.

Couper, William (ed.). 1881. Pigeon Shooting. Can. Sports. Nat., 1(3): 21.

De Cino, T. J., D. J. Cunningham, and **E. W. Schafer.** 1966. Toxicity of PRC-1339 to Starlings. Journal of Wildlife Management 30: 249-253.

deVos, Antoon. 1964. Range Changes of Birds in the Great Lakes Region. American Midland Naturalist 71(2): 489-502.

Dionne, C. E. 1914. Le Pigeon voyageur existe-t-il encore? Naturaliste Canadien 41(1): 1-2.

Dresser, John A., and **T. C. Denis.** 1944. Geology of Quebec, vol. II: descriptive geology. Prov. Quebec Dept. Mines, Geol. Rept. No. 20.

Godfrey, W. Earl. 1956. Some distributional notes on Canadian birds. Canadian Field-Naturalist 70(3): 136-138.

————. 1966. The Birds of Canada. National Museum of Canada, Bulletin Number 203.

Hall, Archibald. 1862. On the mammals and birds of the district of Montreal. Can. Nat. and Geol., 7(1): 44-78; (3): 171-193; (4): 289-316; (5): 344-376; (6): 401-430.

Hall, G. Harper. 1955. Great moments in action: the story of the Sun Life Falcons. Montreal: Mercury Press.

Hickey, Joseph J. and **Daniel W. Anderson.** 1968. Chlorinated Hydrocarbons and Eggshell Changes in Raptorial and Fish-Eating Birds. Science 162 (3850): 271-273.

Jeffries, D. J. 1967. The delay in ovulation produced by pp' — DDT and its possible significance in the field. Ibis 109(2): 266-272.

Le Moine, J. M. 1870. The Wild Passenger Pigeon, *Ectopistes migratorius*. Can. Sports. and Nat., 3(5): 231.

Macoun, John and **James M. Macoun**. 1909. Catalogue of Canadian Birds. Canada: Dept. of Mines and Geol. Surv. Branch, Rept. No. 973.

National Audubon Society. 1947-1968. Audubon Field Notes, vols. 1-22.

Ouellet, Henri. 1966. Biomes et écotones dans la péninsule Québec-Labrador. Naturaliste Canadien 93: 177-186.

————. 1967. The distribution of the Cerulean Warbler in the Province of Quebec, Canada. The Auk 84(2): 272-274.

————. 1969. Les oiseaux de l'île Anticosti, province de Québec, Canada Musée National des Sciences Naturelles, Pub. Zool., No. 1: 1-79.

Province of Quebec Society for the Protection of Birds. 1935-1965. Annual Reports from 1935-1936 to 1965.

Rand, Austin L. 1945. Hungarian Partridge in the Ottawa-Montreal area. Canadian Field-Naturalist 59(1): 26-27.

Rintoul, W. H. 1883. The Passenger Pigeon. Can. Sports, and Nat. 3(6): 242-243.

Snyder L. L. 1951. Ontario Birds. Toronto: Clarke, Irwin and Co. Ltd.

————. 1957. Changes in the Avifauna of Ontario. *in* Changes in the Fauna of Ontario (editor F. A. Urquhart). Royal Ontario Museum, University of Toronto Press.

Terrill, L. M. 1921. The Grasshopper Sparrow in The Montreal District. The Auk 39(1): 113.

————. 1924. Occurrence of the Starling in the Montreal District. Canadian Field-Naturalist 38(3): 58.

————. 1931. Nesting of the Saw-whet Owl (*Cryptoglaux acadica acadica*) in the Montreal District. The Auk 48(2): 169-174.

Wintle, Ernest D. 1896. The Birds of Montreal. Montreal, W. Drysdale & Co.

Wood, N. A. 1951. Birds of Michigan. Misc. Publ. Mus. Zool., Univ. Michigan, 75: 1-559.

Received March 20, 1969
Accepted August 15, 1969

Bedrock Features of the Mer Bleue Area by Seismic Methods[1]

GEORGE D. HOBSON
Geological Survey of Canada, Ottawa, Ontario

A seismic survey has been conducted over the Mer Bleue peat bog and portions of the surrounding area. Initially, seismic data were acquired using a portable hammer refraction seismograph and was confined to the immediate Mer Bleue area but the trends of the bedrock topography map derived were so interesting that the survey was extended using conventional seismic surveying instruments to give a more complete display of the bedrock topography. The seismic survey is complimentary to the geological, biogeochemical, and other studies conducted in the area.

Area surveyed

The area is located south of the settlements of Blackburn and Navan, and north of Edwards, in Gloucester Township of Carleton County and Cumberland Township of Russell County. The area is generally accessible by vehicle over secondary roads although 15 locations were investigated by back-packing the hammer seismic instrument. In total, 189 locations were investigated within an area of approximately 60 square miles.

Seismic Refraction Theory

It is not considered essential to this paper to discuss seismic refraction theory but to point out only that the pertinent data observed is the time interval between the release of energy and its detection by a detector or seismometer. The source of energy can be a small explosive charge or a sledge hammer struck against a steel plate on the surface of the ground. The time interval observed is plotted against distance on squared paper to yield velocities which in turn are introduced into standard formulae for calculation of depth to the various refracting subsurface layers. The reader is referred to Dobrin (1960) for further information with respect to seismic surveying.

Brief Note on Geology

The majority of the locations investigated overlie shale bedrock of the Carlsbad, Billings, and Queenston Formations of late Ordovician age. A few locations north of a major east-west trending fault in the northern portions of the study area overlie bedrock of the Ottawa Formation of middle Ordovician age.

Surficial materials are comprised of recent muck and peat overlying a fine sand which in turn overlies either a fine sandy clay or a very homogeneous clay or a saturated loosely consolidated clay, the clay being considered to be marine deposits of the Pleistocene Champlain Sea. Readers are referred to Wilson (1946) and other papers of this series for a complete and critical presentation of the geology of the area.

Velocities Observed

The histogram of velocities observed, figure 1, is unusual in that the lower velocities are separated by well defined peaks on the histogram. It is infrequent that such distinct separation of velocities is observed. The lower velocity, peaking at about 950 feet per second, is associated with the aerated surface zone which may also relate to the thickness of the peat in the bog area. It is obvious that the ground-coupled air-wave is not a problem in recording true data since the air velocity at 1100 feet per second is not a prominent feature of the histogram.

The histogram peak at about 4650 feet per second indicates a high velocity zone below the

[1]Contribution No. 4 to the series "Scientific and Cultural Studies of the Mer Bleue" (see Canadian Field-Naturalist 83(1): 4-6, 1969).

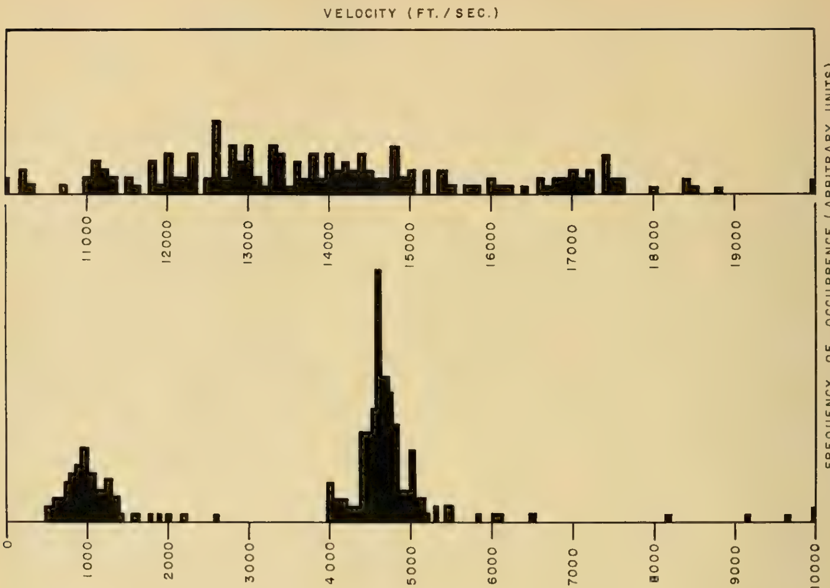


FIGURE 1. Histogram of observed seismic velocity versus frequency of occurrence, Mer Bleue.

peat in the bog area, and is correlated with clay at locations outside the bog. This velocity is very well defined on all time-distance graphs. This velocity range between 4000 and 5500 feet per second may be interpreted as a sandy clay or a saturated clay. Sandy clay will probably evidence a velocity in the lower part of the range whereas a saturated clay with variable composition dependent upon the percentage of water of saturation should have a variable velocity. The top of this clay layer is probably directly related to the water table.

Bedrock generally is indicated by a seismic velocity in excess of 11,000 feet per second and it is variable as shown by the spread of the histogram. This spread of velocities is due to several factors two of which are the dip of the strata and the composition of the strata. It is impossible to correlate bedrock lithology with seismic velocities in this area because shales of similar composition form the bedrock over most of the area. A correlation of apparent seismic velocities with bedrock lithology was attempted by setting down bedrock seismic velocity at all seismic stations plotted on a bedrock geology map. One anomalous fact is revealed in such a presentation; whereas limestone is generally considered to evidence a seismic velocity greater than shale, in this area the apparent seismic velocities in limestone are generally less than those in shale. However the quantity of data collected does not really allow one to define types of bedrock on the basis of their apparent seismic velocities.

Discussion of Data

Bedrock topography is presented in figure 2 superimposed upon surface topography. This

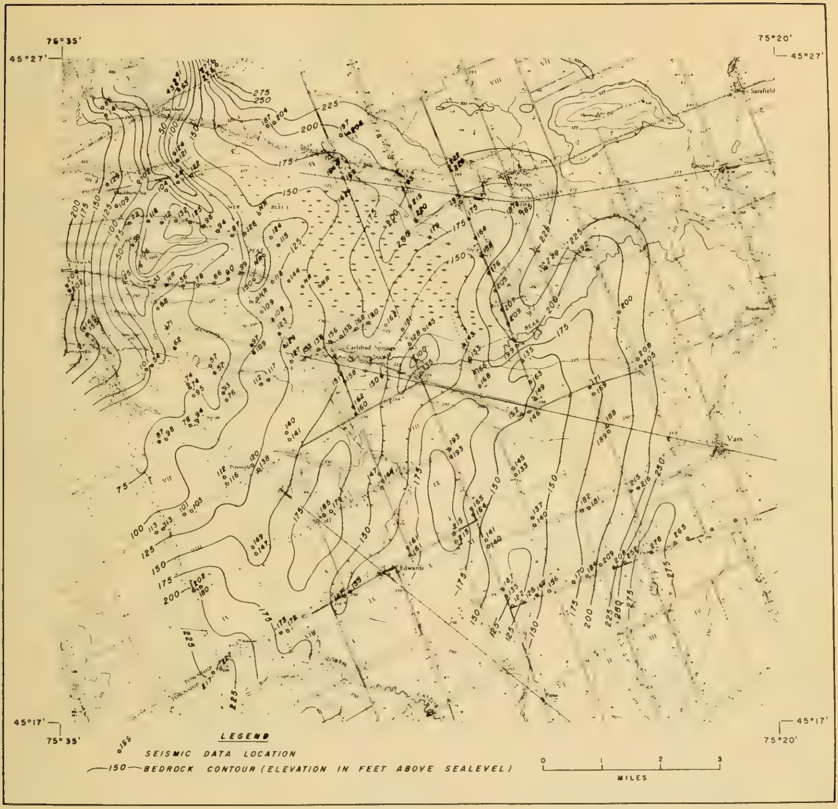


FIGURE 2. Bedrock Topography, Mer Bleue and surrounding area.

presentation permits the reader to calculate overburden thickness by subtracting bedrock elevation based upon a sea-level datum from surface elevation. All pertinent data are thus presented in one figure.

Bedrock contours indicate a topographic grain slightly trending in a NNE-SSW direction. This observation is at variance with that of Wilson (1946) wherein structural strike is indicated as generally east-west and dipping southward. As a result of the seismic investigations bedrock surface slope appears to be westward. A bedrock high of 278 feet above sea level is observed in the extreme southeast corner of the project area while a bedrock depression with elevation of 25 feet above sea level is observed in the northwest portion of the area immediately south of Blackburn Station. It is interesting to note that there is a progression of lows and highs or depressions and ridges orient-

ed in a general north-south direction on the bedrock surface over the area.

Drift thicknesses in excess of 230 feet are observed in the prominent bedrock depression on the west side of the project area. There is a general gradual thinning of overburden toward the east where thicknesses of 5 feet and bedrock outcrops are observed.

The bedrock contours by their general north-south orientation suggest a cross drainage system and perhaps a similarly oriented bedrock fault pattern. This parallelism was first correlated with Green Creek immediately to the northwest of the surveyed area, to the Rideau River further to the west and to the Indian River to the east. However, at first glance, the modern drainage system appears to be transverse to the bedrock drainage system. This is true for certain features but the prominent exceptions noted above cannot be ignored. A perusal of the lineaments on the high-level air photographs of the project and surrounding area also tends to indicate this conclusion. Wilson (1946) also shows a fault perpendicular to the Eardley Fault, a direction parallel to the cross drainage system described in this paper.

Correlation with Boreholes

Two boreholes have been drilled to bedrock at the extreme eastern end of Borthwick Ridge Road in the middle of the Mer Bleue peat bog. These holes encountered bedrock at an elevation of approximately 140 feet above sea level, an elevation that agrees favourably with the bedrock topographic contours determined by seismic methods. The logs of both holes indicate mainly clay above a till (thickness 8 to 14 feet) overlying bedrock.

Conclusions

Bedrock lithology in this area cannot be differentiated on a basis of seismic velocities. The predominant shales of the area all show similar velocities indicating a similarity of physical characteristics of those shales. It is not possible to differentiate the shales and limestones on the basis of apparent seismic velocities because of a lack of sufficient data for the limestone formations.

Overburden thickness in the area varies from outcrop or thin overburden cover on the east to thicknesses in excess of 230 feet in the western regions of the project area with a general gradation of thickness between. Bedrock in the project area is readily detectable by seismic methods.

There are well defined ranges of apparent seismic velocities indicating well defined stratification of overburden materials.

Bedrock contours indicate a cross drainage system and perhaps a fault and block pattern with an orientation in the general NNE-SSW direction. This fault pattern is observable on the air photographs.

Acknowledgments

The seismic project was instigated upon the suggestion of Dr. J. Terasmae and his following interest is appreciated. Field work was conducted by G. P. Killeen and W. Peters using the hammer refraction seismograph and by H. A. MacAulay, R. A. Hodge, and J. M. Shearer using conventional instrumentation. I am indebted to H. A. MacAulay for the computation and reduction of all field data.

Literature Cited

Dobrin, M. B. 1960. Introduction to geophysical prospecting. McGraw-Hill, New York.

Wilson, Alice E. 1946. Geology of the Ottawa-St. Lawrence Lowland, Ontario and Quebec. Geological Survey of Canada, Memoir 241.

Received August 1, 1969
Accepted October 21, 1969

Colonies of Double-crested Cormorants and White Pelicans in Saskatchewan

KEES VERMEER
Canadian Wildlife Service, Edmonton, Alberta

Abstract. A survey of Double-crested Cormorants and White Pelican colonies was made in Saskatchewan in 1968. Nine colonies of Double-crested Cormorants with a total of 1078 nests and eight colonies of White Pelicans with a total of 6,558 nests were observed. One new location with the largest nesting population of White Pelicans in Canada has been described. Because of a decline of breeding colonies of both species, protection of their nesting habitat has been urged.

Introduction

A survey of nesting colonies of Double-crested Cormorants (*Phalacrocorax auritus*) and White Pelicans (*Pelecanus erythrorhynchos*) was made in Saskatchewan during the summer of 1968, incidentally to a study of pesticide residues in the eggs of these birds. One or two colonies may have been missed as the survey was not exhaustive. The survey was conducted by car, boat, and plane.

Acknowledgments

Messrs. H. Blokpoel and R. Isbister, Canadian Wildlife Service; Mr. S. G. Sealy, University of Michigan; and Mr. C. Scott, Alberta Fish and Wildlife Division, assisted in locating nesting colonies. Dr. C. S. Houston provided information on the nesting colony of Double-crested Cormorants at Churchill Lake.

Results and Discussion

Figure 1 depicts the active nesting colonies of Double-crested Cormorants and White Pelicans found in Saskatchewan in 1968. The numbered colonies shown in Figure 1 are identified in Table 1.

The majority of the active colonies shown in Figure 1 have been described previously (Anderson and Bartonek 1967; Carson 1966; Houston 1962 and 1966; Lahrman 1957; Lies and Behle 1966; Sanderson 1966). As no published description of the colonies at Primrose Lake was found, they are briefly described here.

Figure 2 depicts the islands in Primrose Lake on which Double-crested Cormorants and White Pelicans are nesting. Backes Island was first visited on July 29, 1967. There were then 800-1,000 young pelicans on the island. No nests of Double-crested Cormorants were found there that year. Twenty-five active nests of Great Blue

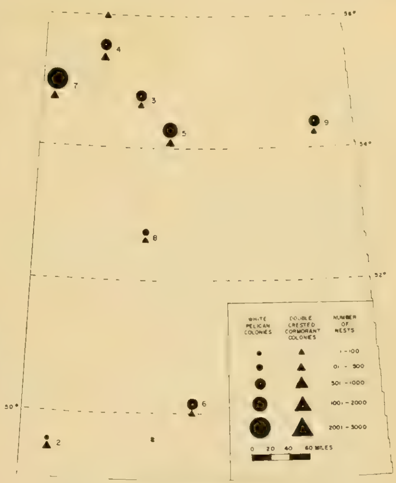


FIGURE 1. Nesting colonies of Double-crested Cormorants and White Pelicans in Saskatchewan.

Herons (*Ardea herodias*) were situated in *Populus tremuloides* trees. Half a dozen nests of Herring Gulls (*Larus argentatus*) and numerous nests of California Gulls (*Larus californicus*), Ring-billed Gulls (*Larus delawarensis*), and Common Terns (*Sterna hirundo*) were observed. One pair of Caspian Terns (*Hydro-*

FIGURE 2. Nesting islands of Double-crested Cormorants and White Pelicans in Primrose Lake.

progne caspia) appeared to defend a territory but no young ones were seen. Backes Island was visited again on June 18, 1968. In that year there were 2,256 nests of White Pelicans and 35 nests of Double-crested Cormorants. Although many California Gulls, Ring-billed Gulls, and Common Terns nested on the island, no Herring Gull nests were found in 1968. Twenty active nests of Great Blue Herons were observed. A small rocky island, close to the shore, was also visited at this date and 203 nests of White Pelicans and 99 nests of Double-crested Cormorants were counted there.

The White Pelican colony at Primrose Lake is the largest known in Canada. In 1968, the largest White Pelican colony observed in Alberta was at Namur Lake with 290 nests, while the only colony observed in British Columbia was at Stum Lake with an estimated 85 breeding pairs. The largest colony east of Saskatchewan contains about 1,000-1,200 breeding pairs at Pelican Lake, Manitoba (Anderson and Bartonek 1967).

Colonies of Double-crested Cormorants and White Pelicans formerly reported from Saskatchewan but which have since disappeared are shown in Table 2. Colonies referred to in the literature but lacking in supporting figures on numbers of breeding pairs, nests, and young have been omitted from Table 2. Several colonies disappeared as a result of falling lake levels or human disturbance (Houston 1962). Many active colonies are still susceptible to human disturbance. Carson (1966) reported a large-scale destruction of nests of White Pelicans and Double-crested Cormorants by fishermen at Suggi Lake in 1964. Houston (1962:76) reports of a visit in 1956 to the White Pelican colony at Doré Lake: "The conservation officer informed me that local ranchers were in the habit of taking boat loads of eggs from these colonies to feed their mink, rationalizing that the fish-eating birds were harmful to the fishing interests on the lake."

Fortunately the second largest colony of White Pelicans in Saskatchewan, at Lavalleé Lake has at least maintained its numbers since 1940 when Soper (1952) visited it. It is afforded the protection of being within Prince Albert National Park.

According to Houston (1962), Redberry Lake may soon be in danger owing to the increasing use of the lake as a resort. Even the largest White Pelican colony, situated within the Canadian Forces Air Weapons Range at Primrose Lake, is potentially endangered because the pelicans create a hazard for the new CF-5 aircraft (H. Blokpoel, pers. comm.). An extensive decline of White Pelicans occurred during the last decades in Alberta (Vermeer 1969). Some of the Alberta colonies disappeared as a result of human disturbance (Soper 1952). Protection for White Pelican colonies has been urged by Houston (1962), Lies and Behle (1966), Soper (1952), and Thompson (1933). With the exception of the national park protection afforded the Lavalleé Lake colony, little action has been taken in Canada to protect White Pelican colonies, while most White Pelican colonies in the United States are within National Wildlife Refuges. The islands on which the Double-crested Cormorant and White Pelican colonies in Canada are situated are

TABLE 1 Number of nests and location of active colonies of Double-crested Cormorants and White Pelicans in Saskatchewan in 1968.

Colony location	Latitude	Longitude	Number of nests	
			Double-crested Cormorant	White Pelican
1. Churchill Lake	56 00′N	108 10′W	4	0
2. Cypress Lake*	49 30′N	109 25′W	434	12
3. Doré Lake	54 45′N	107 10′W	70	600
4. Kazan Lake	55 35′N	108 20′W	152	902
5. Lavalleé Lake	54 20′N	106 35′W	122	1020 (1161)**
6. Old Wives Lake	50 05′N	155 55′W	45	746
7. Primrose Lake	55 00′N	109 40′W	136	2459
8. Redberry Lake	52 40′N	107 10′W	62	139
9. Suggi Lake	54 20′N	102 50′W	55	680
Total nests			1078	6558

* Observed in 1969.
** Number counted by Lahrman and Greyell in 1968 (Greyell, 1968)

almost all government property. Hence, little money is necessary to give these islands special protection.

It has been charged that Double-crested Cormorants and White Pelicans consume large quantities of fish of great economic value. But Thompson (1933) reported that in most cases the pelicans feed primarily upon fish of little or no human value, while Lewis (1929:87) stated that "as the result of an examination of more than 550 meals, chiefly freshly regurgitated, and the consideration of numerous other detailed records it is found that the Double-crested Cormorant does little economic injury". Some people do not think it necessary to protect Double-crested Cormorants and White Pelicans

TABLE 2. — Location and size of former Double-crested Cormorant and White Pelican colonies in Saskatchewan

Species	Colony location	Number of breeding pairs	Last date observed occupied	Source
Double-crested Cormorant	Big Stick Lake	few	1906	Bent, 1922
	Crane Lake	87	1961	Houston, 1962
	Last Mountain Lake*	90	1958	Houston, 1962
	Little pelican Lake	ca. 500	—	Lewis, 1929
	Moose Mt. Prov. Park	ca. 50	1958	R. Fyfe, pers. comm.
	Stoney Lake	ca. 25	—	Lewis, 1929
	Quill Lakes	ca. 300	1957	Houston, 1962
	Wakaw Lake	ca. 125	—	Lewis, 1929
White Pelican	Big Stick Lake	ca. 1000	1907	Bent, 1922
	Crane Lake	256	1961	Houston, 1962
	Last Mountain Lake	28	1954	Houston, 1962
	Manito Lake	ca. 300	1930	Houston, 1962
	Quill Lakes	ca. 1000	1958	Houston, 1962

* Repopulated by small cormorant colony in 1969 (J. P. Hatfield, personal communication).

as they have no monetary value. Cottam and Uhler (1937:3-4) replied to those holding that view: "One might as well inquire what good is a masterpiece of Rembrandt or Corot or an orchestral symphony of Beethoven! — — The apeal of a colony of nesting birds, such as egrets or pelicans, for example, without doubt has been a factor in attracting tourists to various parts of the country."

Literature Cited

Anderson, D. W. and **J. C. Bartonek.** 1967. Additional observations on the status of North American White Pelicans. Condor, 69: 311-313.

Bent, A. C. 1922. Life histories of North American petrels and pelicans and their allies. Dover publications 1964. New York. 335 pp.

Carson, R. D. 1966. Destruction of colonial birds on an island on Suggi Lake. Blue Jay, 24: 96-97.

Cottam, C. and **F. M. Uhler.** 1937. Birds in relation to fishes. Wildlife research and management leaflet. BS-83. United States department of agriculture. Bureau of biological survey, 16 pp.

Greyell, B. 1968. Preliminary park inventory and interpretation plan. National Parks Branch mimeo report. 31 pp.

Houston, C. S. 1962. Hazards faced by colonial birds. Blue Jay, 20: 74-77.

Houston, C. S. 1966. Need for pelican protection. Blue Jay, 24: 123.

Lahrman, W. F. 1957. Birds of the Isle of Bays, 1957. Blue Jay, 15: 106-109.

Lewis, H. F. 1929. The natural history of the Double-crested Cormorant (*Phalacrocorax auritus auritus* L.) Published Ph.D. thesis, Ottawa, 94 pp.

Lies, M. F. and **W. H. Behle.** 1966. Status of the White Pelican in the United States and Canada through 1964. Condor, 68: 279-292.

Sanderson, R. M. 1966. The colonial birds at Suggi Lake, Saskatchewan, in 1966. Blue Jay, 24: 121-123.

Soper, J. D. 1952. The birds of Prince Albert National Park, Saskatchewan. Wildlife management bulletin. Series 2. Number 4. 83 pp.

Soper, J. D. 1952. Protection of wildfowl breeding grounds in the Lake Newell locality, Eastern Irrigation District, Alberta. Canadian Wildlife Service, Edmonton, 26 pp.

Thompson, B. H. 1933. History and present status of the breeding colonies of the White Pelican (*Pelecanus erythrorhynchos*) in the United States. United States Department of the Interior. National Park Service. Occasional Paper Number 1. 82 pp.

Vermeer, K. 1969. Colonies of Double-crested Cormorants and White Pelicans in Alberta. Canadian Field-Naturalist, 83: 36-39.

Received May 27, 1969
Accepted October 16, 1969

Studies of Vegetative Regeneration in *Saponaria officinalis* L. (Soapwort) and *Silene cucubalus* Wibel (Bladder Campion)[1]

MARGUERITE A. LUBKE AND P. B. CAVERS
Department of Botany, University of Western Ontario, London, Canada

Abstract. *Saponaria officinalis* and *Silene cucubalus* are perennial species which occur on the limestone gravel banks of the Thames River, Western Ontario. In pasture both are troublesome weeds. Regeneration of fragments of the underground systems of both species was studied to determine the potential of the underground structures for stabilizing the mobile gravel in their riverside habitats. Also a knowledge of the mode of regeneration of these species might aid in formlating methods to eradicate them from pasture. The results indicate that even small portions of rhizome of *Saponaria officinalis* will regenerate in the summer but are less likely to do so in the spring and autumn. The rhizomes are not ideal for gravel stabilization because the greater part of the underground system has died and rotted before spring floods occur. Only underground portions of *Silene cucubalus* which include stem tissue are able to regenerate but this species would be more effective in stabilizing gravel.

Both *Saponaria officinalis* and *Silene cucubalus* are prominent members of the gravel bank flora along the Thames River, Western Ontario (Figure 1). The gravel there is of limestone origin. It is highly porous and mobile due to the lack of binding material. The mobility of the substrate is a prime cause of the continuing changes in the shape of the banks and the river. Occasionally fences, buildings and other property are destroyed through such action.

The flora of these gravel banks is usually sparse and many of the more common species are short lived annuals, whose roots do little to stabilize the gravel. For this reason, knowledge of the characteristics of the root systems of the few perennial herbs which do exist in this habitat (e.g. *Saponaria officinalis* and *Silene cucubalus*) may be of benefit in choosing species which could be planted to maintain the structure of the banks.

In addition, *Saponaria officinalis* and *Silene cucubalus* are both economically important in Ontario because they occur as part of the weed flora of pasture land. The seeds of *Saponaria officinalis* are poisonous to livestock, and *Silene cucubalus* is listed as one of the primary noxious weeds in the province (Montgomery, Switzer and Kingsbury 1962). Any information on the responses of severed portions of the underground systems of these species may also be valuable when eradication programmes are contemplated.

This study was restricted to plants collected from the gravel banks along the Thames River in Western Ontario and is chiefly concerned with the rhizomes of *Saponaria officinalis*. Only a brief study was made of the regeneration capacity of parts of the underground system of *Silene cucubalus*.

Saponaria officinalis has a stout, branched, creeping rhizome at the nodes of which arise long stolons, erect or ascending flowering shoots and fibrous adventitious roots. Fibrous roots may also develop at the nodes of shoots in the region below the soil surface (Figure 4).

Silene cucubalus is another perennial member of the Caryophyllaceae but its underground system is not rhizomatous. It consists instead of a crown below the soil surface from which arise a number of fleshy main roots which penetrate deeply into the soil and may branch. Leafy shoots which arise at the crown often pass through several centimetres of soil before reaching the surface.

Winter and spring floods, particularly those which transport large chunks of ice and debris, can cause much movement of gravel and considerable changing of the contours of unstable

[1]This paper forms part of a thesis submitted by the senior author to the Faculty of Graduate Studies, University of Western Ontario as partial fulfillment of requirements for the M.Sc. degree.

gravel banks. The root systems of *Saponaria officinalis* and *Silene cucubalus* are often torn apart during floods. We have observed that the resulting fragments are transported downstream on occasion. We have also observed regrowth from such fragments of *Saponaria officinalis*. Periodic flooding does occur during other seasons but we have observed little disturbance of the gravel or the vegetation except when ice is present.

The experimental material was not placed on the gravel banks because conditions there lack uniformity and because summer drought might have prevented regeneration which would otherwise have occurred. Also, many fragments would probably have been washed away during the winter. The object of this work was to evaluate the potential for regeneration of underground portions of these two species.

Materials and Methods

Every month from May until September, 1967, the rhizome systems of five healthy plants of *Saponaria officinalis* were carefully excavated from a gravel bank on the campus of the University of Western Ontario. For each plant the three largest rhizomes were used. One was cut into 2.5 cm lengths, another into 5 cm lengths and the third into 7.5 cm lengths. The number of fragments of each size varied according to the size of the original rootstock (Table 1). The cuttings were laid horizontally on a 3 cm depth of silica sand in a wooden seed flat and covered with a further 1 cm depth of sand. They were then watered thoroughly and the boxes were set outside in partial shade in a completely randomized pattern. Regeneration was noted when a shoot emerged from the sand.

In both July and August, 1967, three robust plants of *Silene cucubalus* were carefully excavated from the gravel banks in Gibbons Park, London (Figure 1). The region of stem arising from the crown but below the soil surface was used in these studies; three from each plant were selected and chopped into 2.5, 5 and 7.5 cm lengths. Also the tap root of each plant was cut into 2.5 cm portions. The material was then

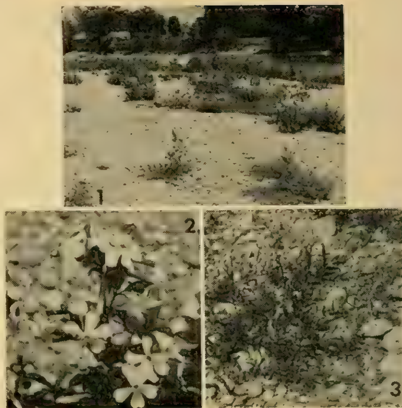


FIGURE 1. Riverside gravel bank in Gibbon's Park, London, Ontario. Clumps of both *Saponaria officinalis* and *Silene cucubalus* are present in this picture.

FIGURE 2. A plant of *Saponaria officinalis* in flower on the same gravel bank.

FIGURE 3. A plant of *Silene cucubalus* in flower on the same gravel bank.

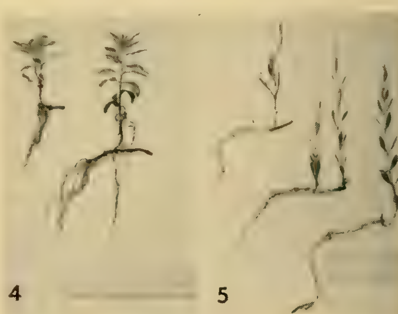


FIGURE 4. Regenerated rhizome fragments of *Saponaria officinalis*. On the left is a 2.5 cm fragment, on the right is a 7.5 cm fragment.

FIGURE 5. Regenerated fragments of *Silene cucubalus*. Note that shoots are produced only at the nodes; roots only at the extreme end of the fragment, distal to the stem tissue.

treated in the same way as that of *Saponaria officinalis*.

By September, most of the shoots of *Saponaria officinalis* which arose from older rhizomes during the summer had given rise to plants which were no longer dependent upon such rhizomes for food material. These older rhizomes had rotted away. The newly established small plants were producing their own rhizomes which were very fine and thin.

These new rhizomes constituted the entire September collection. None of them produced buds within a month. Also, the banks were inundated beneath flood waters on the days when the October and November collection should have been made. For these reasons no further samples were taken that year.

All flats were left in position throughout the winter. The number of regenerated plants which had survived was recorded in the following spring. At that time a selection of root portions was removed and washed to expose the origin of shoots and roots.

Results

The results are presented in tables 1 and 2 and figures 4 and 5. The capacity for regeneration of fragments of *Saponaria officinalis* in the same year was at its peak in July and August, but dropped to nil in September when the new rhizomes were used (Table 1). Throughout the experiment, fragments of 5 cm or longer were more likely to produce buds than those of 2.5 cm length. This was probably correlated with the frequency of nodes along the rhizome. The internode lengths ranged from 2 to 4 cm, hence it was possible to cut a 2.5 cm fragment which had no node at all. Also there was no activity at certain nodes (see Figure 4).

The following year a high proportion of these regenerated plants had survived, and in addition, shoots appeared from some fragments collected in September (Table 1). No new shoots appeared after the winter in any boxes containing fragments from the other sampling times. Examination of the rhizome portions (Figure 4) shows that the shoots are generated at the nodes, as are the adventitious roots.

Neither the size of the fragment nor the time of its collection had any obvious effect on the time taken for regeneration.

In *Silene cucubalus* only pieces which included tissue from the crown were able to produce shoots (Table 2). There was no regrowth from portions of the tap root. Failure of regeneration from some fragments was probably due to a lack of nodes in these portions. All the regenerated fragments survived until the following year. An examination of Figure 5 shows that shoots are only produced at the nodes, and that roots arise at the end of the fragment distal to the stem tissue.

Discussion

Fragmentation of plants is most likely to take place in the late spring at the time when ice chunks scrape and dislocate the unstable gravel substrate. However, regeneration of fragments which were severed in May and June was less successful than for fragments collected in July and August when the plants were growing vigorously. Possibly the supply of carbohydrates and other nutrients was depleted in the smaller rhizomes which were present in the early spring. The extremely slow growth of new shoots in the spring may also be a response to a lack of food in the rhizome at that time.

The lack of regeneration until spring of the fragments collected in September was probably of great importance for their survival. If such a fragment had produced shoots during the fall these would undoubtedly have been destroyed during the winter with a consequent wastage of a large portion of carbohydrates stored in the rootstock. Also, if fragments are transported to new sites before they begin to regenerate, their chances for survival would be improved.

It is probable that many of the 2.5 cm fragments failed to regrow because there was no node on that portion of the rhizome. However, it should also be noted that plants which did arise from these smaller fragments were less likely to survive the winter than plants from larger ones.

Work by Hudson (1955) on a variety of plants showed that some species regenerate

TABLE 1. — The regeneration of rhizome fragments of *Saponaria officinalis* collected at different times of the year.

	Month of Sample														
	May			June			July			August			September		
Size of Fragment	2.5 cm	5.0 cm	7.5 cm	2.5 cm	5.0 cm	7.5 cm	2.5 cm	5.0 cm	7.5 cm	2.5 cm	5.0 cm	7.5 cm	2.5 cm	5.0 cm	7.5 cm
No. of fragments used	24	16	14	23	19	11	21	15	15	24	12	9	16	10	13
No. of fragments which regenerated in same year	6	7	6	2	4	8	9	14	11	10	8	8	0	0	0
Percentage regeneration in same year	25	44	43	9	21	73	43	93	72	42	67	89	0	0	0
Mean time taken for regeneration in days	20	25	33	38	15	17	30	22	20	30	31	28	—	—	—
Percentage of all fragments which had vigorous shoots the following spring (May 1)	4	44	29	4	21	55	24	73	53	13	33	67	13	40	0

readily from root or rhizome cuttings at any time of the year (e.g. *Taraxacum officinale* and *Cochlearia armoracia*) whilst others are strongly seasonal in their capacity for regeneration (e.g. *Populus nigra* and *Phlox paniculata*). In this British study, regeneration was greater in the winter months for all species found to have a seasonal cycle. In contrast, the proportion of fragments of *Saponaria officinalis* which regenerated was greatest in the two summer months of July and August but collections were not possible for the winter months.

The September excavations revealed that vegetative reproduction occurs regularly in *Saponaria officinalis*. This characteristic may be of critical importance to the success of this widespread and abundant species. *Saponaria officinalis* is often found growing in clumps several yards across. These clumps are probably formed through vegetative spread from one small individual.

It has been shown that the roots of *Silene cucubalus* are unable to regenerate shoots unless underground stem tissue, as found in the crown is present. This finding is consistent with the observations of Cavers (1963) for *Rumex crispus* and *R. obtusifolius*. The ability of an underground stem to reproduce a shoot readily, whilst probably not unusual, might be advantageous. If several stem portions from one plant are detached, and each regenerates, this would constitute a supplementary means of reproduction.

The spreading rhizomatous habit of the underground system of *Saponaria officinalis* would apparently make it a good species for binding and stabilizing the surface layers of gravel. Unfortunately, the degeneration of much of the parent rhizome tissue by September and the production of only slender rhizomes by the daughter plants by this time means that it is

TABLE 2 Percentage regeneration of portions of underground stem of *Silene cucubalus* during the year of planting (Actual proportion shown in brackets).

Size of fragment	Month of sample	
	July	August
2.5cm	67 (6/9)	78 (7/9)
5.0cm	80 (4/5)	67 (6/9)
7.5cm	100 (3/3)	83 (5/6)

All these plants survived until the following year.

much less effective as a stabilizing species through the winter and early spring months when gravel movement is greatest. Although *Silene cucubalus* lacks a horizontal system, it has a persistent, stout and deeply penetrating root system which branches, and this will serve to hold the gravel in the immediate vicinity of the roots. This species appears to have greater potential than *Saponaria officinalis* for stabilizing open gravel.

Acknowledgments

The authors are grateful to the Canadian National Sportsmen's Show and the National Research Council of Canada for financial support for this work.

Literature Cited

Cavers, P. B. 1963. Comparative biology of *Rumex obtusifolius* L and *R. crispus* L including the variety *trigranulatus*. Ph.D. Thesis, University of Wales.

Hudson, J. P. 1955. Propagation of plants by root cuttings II. Journal of Horticultural Science 30(4): 242-251.

Montgomery, F. H., C. M. Switzer, C. H. Kingsbury. 1962. Ontario Weeds. Ontario Department of Agriculture Publication 505.

Received February 10, 1969
Accepted August 13, 1969

Nardus stricta L., Moor Matgrass at Lac Carré, Terrebonne County, P.Q.

Dorothy E. Swales[1] and J. R. Bider[2]
Macdonald College, P.Q.

Abstract. *Nardus stricta* L. was recorded for the third time in Quebec and the fifth time in continental Canada at Lac Carré, 46°09' N., 74°29' W. The roots were confined mainly to the top layer of soil, 17-20 cm deep. Root-tip preparations showed 26 somatic chromosomes. It occurred on Guindon soil with a pH of 5.4, but failed to spread to adjacent open areas of Ivry soil with a pH of 5.2-5.4, slightly lower in mineral content and water-holding capacity, although both are podsol soils. The stand was over thirty years old and apparently did not originate through the activities of the farm owners, but *may* have through the agency of migrating woodcock or sparrows, or by immigrant sportsmen from the British Isles carrying grains in their pantcuffs or other parts of their hunting clothes. Although *Nardus* fruits freely, its very slow spread and its limitation to one soil type at Lac Carré suggests that it will not become a pasture pest under our climatic conditions.

Nardus stricta L., recorded only twice before in Quebec (near the Maine border in 1935 and 1936) was discovered in four sites within five acres of acid, sandy soil at Lac Carré (46°09' N,. 74° 29' W.) in the Laurentians in September, 1968. A casual sample of the grass was determined by W. G. Dore, who had found it at Clyde River, Nova Scotia, in 1942 and was the first to publish the record of its occurrence in continental Canada (Dore 1940). He suggested that the age of the stand and the history of the farm should be studied for possible clues to its introduction and spread there. Following his advice, detailed notes were made on the four sites at Lac Carré, in the northernmost section of Lot 31, Range VIII, Wolfe Township, and the results follow:

Site I

The largest and densest stand of this grass was on a small open plateau surrounded by mixed coniferous and deciduous woods, some twenty feet above the Wildlife Field Laboratory (Figure 1). It was confined to an old stream bed on Guindon soil (Lajoie 1960). The only plants in close physical association with the clumps were *Brachythecium salebrossum,* an inconspicuous delicate moss tangled among the base of the shoots, and conspicuous *Polytrichum commune* and *Lycopodium clavatum* covering the small openings left by the branching rhizomes. The gaps between the clumps were filled with *Solidago rugosa* and *Danthonia spicata.* The general pale-green to straw colour of the plants was so striking against the darker green of the other plants that J. R. Bider remembered noticing the stand in 1952. The rhizomes in clumps examined had grown 25-30 mm per year and, judging from the size of the largest, *Nardus* must have been established in this site for more than thirty years.

The 70 foot long strip of *Nardus* ended abruptly on the west side with a fairly solid stand of *Polytrichum* and *Lycopodium* sprinkled with small *Populus tremuloides, Salix* sp. and the occasional *Kalmia angustifola.* The stand ended just as abruptly on the east side with a ridge of tall trees, *Abies balsamea, Populus tremuloides, Betula papyrifera* and *Prunus serotina.*

The abrupt margin of the *Nardus* stand coincided with an abrupt change from the fine sandy loam of the Guindon soil, with a pH of 5.4, to the coarser loamy sand of the Ivry soil (Lajoie 1960), the latter marked by second layer, two to ten inches thick, of pale grey leached (podsolized) soil. The Ivry soil had a pH varying from 5.2 in the top layer to 5.4 in the succeeding two layers. The Guindon soil had no grey leached layer and a somewhat higher water-holding capacity and mineral content than the Ivry soil, resulting in greater fertility. The inherent fertility and water-holding capacity of *both*

[1]Curator, Macdonald College Herbarium
[2]Assistant Professor, Department of Woodlot Management

FIGURE 1. Pale-coloured *Nardus stricta* on Guindon soil in Site I showing abrupt margins of stand where soil type changes to Ivry. Dead *Solidago rugosa* conspicuous between clumps. Photographed Oct. 22, 1968.

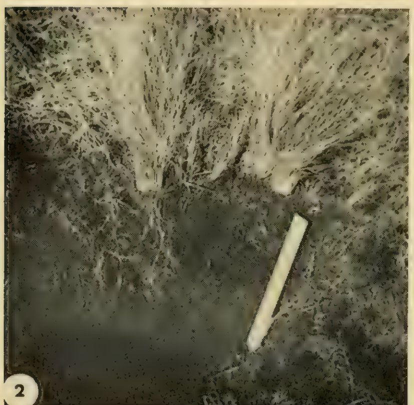


FIGURE 2. *Nardus stricta* showing closely-packed leafy shoots on rhizomes, and roots penetrating only to base of top layer of soil.

soils is low, but *Nardus stricta* is a true calciphobe and grows on acid soils low in nutrients in Europe (Chadwick 1960). These Guindon and Ivry soils are of Precambrian alluvio-lacustrine origin (Lajoie 1960). *Nardus* has tightly folded leaves with a high proportion of sclerenchyma tissue and a correspondingly low percentage of chlorophyll tissue (Figure 4). The rhizomes are unique among grasses in Canada in having the bundles of leaf sheaths packed so closely, two or three abreast, that there were as many as ten to fifteen on 2 cm lengths of rhizome (Figure 2). The density of the clump, and the leaf form are presumably xerophytic modifications, cutting down water loss.

However, the apparent inability of *Nardus stricta* to thrive on the Ivry soil while growing well on the Guindon soil immediately bordering it, might indicate an ecotype which under our particular climate conditions, reached the limit of its tolerance of low water and low nutritive supply on the latter soil. Significant in this regard is the fact that the European plant is described as having a horizontal spreading root system of 30-40 cm, and a depth penetration of 50 cm or more, while our plants had no spreading root system and a depth penetration of only 17-20 cm. J. de Coulon, quoted by Chadwick (1960), states that its drought resistance is largely due to its extensive root system. If this type of growth is general in Europe it could make *Nardus* less sensitive to the water content of soils there than in our area. Some importance may be attached to the fact that the top layer of the Guindon soil contained amounts of humus noticeable to the eye, while the Ivry soil did not. Hegi (1935) observed in Switzerland that in order to survive *Nardus stricta* required a certain, although small, humus content of the soil.

Site II

A second area 70 yards south of, and lower than, Site I had many large clumps of *Nardus,* this time separated by gaps of two or three yards filled by other grasses and *Solidago rugosa.* This stand, again in Guindon soil, probably was established after the above one by caryopsis-carrying water flowing down in the spring. The

Nardus clumps in both Site I and II were dissected by the runways of *Microtus pennsylvanicus*, the meadow vole, whose activities might well have contributed to the spread of the grass in the immediate vicinity.

Site III

Several clumps of *Nardus*, from one foot to three feet in diameter, were in an open meadow, in line with, but 20 feet below the above sites. The grassy sward was dominated by *Danthonia spicata*, and the soil had a pH of 5.6.

Site IV

This site was toward the base of a west-sloping hill below a seven-year-old planting of Jack pines, but in the channel of air drift from Sites I and II on the plateau. There were a few widely separated small clumps of *Nardus*, partially shaded by pines in the morning, and associated with *Danthonia spicata, Agrostis alba, Festuca rubra, Festuca ovina, Achillea millefolium*, and *Rubus groutianus*. The introduction of *Nardus* to this site was probably through wind-blown caryopses or birds. It was fruiting freely all on sites in 1968.

Chromosomes

Apart from the less extensive root system of *Nardus stricta* in the Laurentians, our population appeared identical with those described in the British Isles, and continental Europe as well as with the specimen in the Macdonald College Herbarium from Greenland, at 60°37' N., 44°42' W. Root-tip squashes of a plant from the Lac Carré population provided several good cells for the study of metaphase figures and all showed 26 somatic chromosomes (Figure 3).

The literature shows some variations in counts in various areas of the world. Although the somatic count is n = 26 in the British Isles and continental Europe, Löve and Löve listed counts of $2n = 26$, 27, 28, 29 and 30 in different Icelandic collections (Löve and Löve 1956), while Bowden found $2n = 30$ in two collections made by I. J. Bassett in 1949 in Newfoundland (Bowden 1960). Such differences could be the result of low vagility and long-standing geographic isolation of the *Nardus* populations. Chromosome counts of other North American populations might shed light on the origin of *Nardus* at Lac Carré.

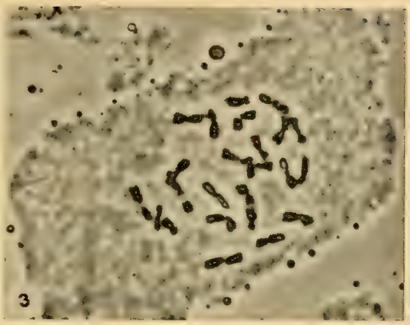


FIGURE 3. Squashed cell from root-tip of *Nardus stricta* showing somatic chromosomes, $2n = 26$. Preparation and photo by W. F. Grant.

Possible Avenues of Introduction of *Nardus stricta* to Lac Carré

The 100 acre farm in the Laurentians, on which *Nardus stricta* was found, was originally purchased from the Crown in 1906 by a Montreal woman for $52.94! It was held until 1921, when it was sold to Mr. Fleurant, who built the first house and broke the land. He resold the farm to another local man, Mr. Pierre Millette, who, in turn, passed it on to his son, Lucien.

All three families carried on subsistence farming, augmenting their incomes by woodcutting. They lived very sedentary lives, for example, Lucien had travelled as far as Montreal only once by 1956! Their scrub cattle were bought locally, and were pastured near the house, three-quarters of a mile from the spot where *Nardus* was found. The fields around the *Nardus* area were used for hay in 1952 when visited by J. R. Bider, and the cows were confined to distant stoney areas unsuited for meadow. The land was bought by F. A. Bider in 1953, long after *Nardus stricta* was established.

The very restricted movements of the early owners of the land, the lack of importation of

stock, and the local purchase of simple farm machinery almost certainly precludes the introduction of *Nardus* through these channels.

Previous findings of this grass in Quebec were remote from Lac Carré and of small size: 1) on a raised sandy hummock in a bog near Lake Megantic, Megantic County (coll. Frère Marie-Victorin 1935)*, and 2) in a quarter-acre patch in an old field by a stand of cedars at Weedon Centre, Wolfe County (coll. Frère Marie-Victorin and James H. Whyte 1936)**. The single Ontario record was from still further away, a 100 yard long patch at Ilfracombe in the Muskoka district (coll. S. L. Thompson 1943) (Montgomery 1956). The only other Canadian stands, at Clyde River, N.S., and Newfoundland (Dore and Roland 1942) could scarcely be the source of the *Nardus stricta* at Lac Carré. However, the few isolated stations in New Hampshire, New York, Massachusetts and Michigan are situated along the Atlantic and Mississippi flyways, which have branches over the Montreal area, and are followed by northern flying birds in the spring (Lincoln 1950). Ground-feeding sparrows or woodcock conceivably could have carried the needle-like grains in their plumage. Even one seed deposited in a soil perfectly suited to this grass might have provided for a successful introduction. Nesting woodcock are quite common in the area from late April through the summer.

Another possible avenue of introduction of *Nardus stricta* would be by European immigrants who went hunting, and who conceivably could have carried over large numbers of seeds in their hunting clothing, particularly their pant-cuffs. (See Taylor 1968) The grass is very abundant on the well-hunted moors of the British Isles. It is striking that its establishment in continental Canada seems to be confined to wild areas suited for deer hunting or shooting upland game, and that sportsmen often pick up seeds on their hunting clothes and discard them during rest periods.

*From herbarium specimen label, Univ. of Toronto.
**From herbarium specimen label, Univ. of Toronto, and personal letter from J. H. Whyte, Univ. of Alberta.

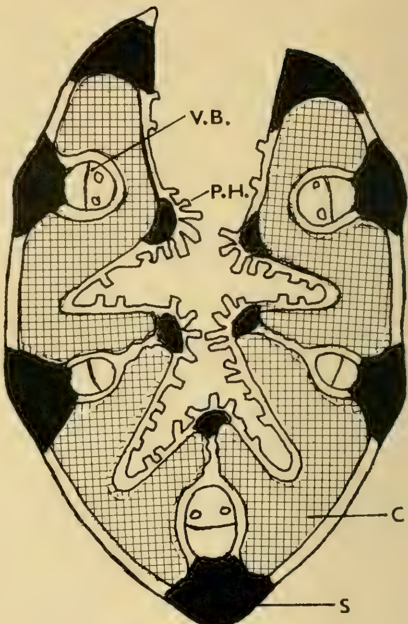


FIGURE 4. Cross section of leaf of *Nardus stricta* showing abundant sclerenchyma forming girders to vascular bundles (V.B.) and reduced chlorenchyma tissue (C). Prickle hairs, 12-24μ, (P.H.) numerous on ridges of adaxial surface and at margin of leaf. Macrohairs, 240-288μ, on abaxial surface, not shown.

Discussion

Is there a possibility that *Nardus stricta* could become a pest in Canada as it has in the sheep-grazing areas of the moorlands in the British Isles and on the alpine meadows of Switzerland? The unusually high percentage of sclerenchyma tissue, compared with that of our well-established pasture grasses in Quebec, is a visual indicator of its woody nature and low nutritional value, particularly as lignification progresses during the summer. (Figure 4). However, the evidence from the Lac Carré study indicates

that, although it spread within a five-acre area in 30 years or more, through water and wind dispersal of the caryopses, and help from meadow voles and birds, the species seems to be extremely selective of soils and very slow-spreading under our climatic conditions. The rhizomes elongate only 20-30 mm per year, in sharp contrast to the growth of 50 cm or more made by that successful introduced grass pest, *Agropyron repens*. On the other hand it will not be limited by low temperatures in this country, as it grows in Greenland, Arctic Scandinavia, and in the Murmansk region, east to the foothills in the U.S.S.R. (Rebristaya *et. al.* 1964). It *will* be limited by the fact it is a calciphobe, shown to be confined to acid soils, and unable to compete with better pasture plants on limed and fertilized soils in its European habitats. It is, therefore, unlikely to become a problem on good farmlands in Canada.

Acknowledgments

Our grateful thanks go to Dr. W. G. Dore for information on previous findings of *Nardus stricta in* Canada, to Dr. W. F. Grant for photographing the chromosomes after determining their number, to Dr. R. R. Ireland for the identification of the moss *Brachythecium*, and to Dr. J. F. G. Millette for classifying the soil samples from Lac Carré.

Literature Cited

Bowden, Wray M. 1960. Chromosomes, numbers and taxonomic notes on northern grasses. Canadian Journal of Botany 38: 552.

Chadwick, M. J. 1960. Biological Flora of the British Isles. No. 74. *Nardus stricta* L. Journal of Econlogy 48: 255-267.

Dore, W. G. 1940-41. Pasture hummocks. Scientific Agriculture 21: 63-69.

Dore, W. G., and **Roland, A. E.** 1942. Grasses of Nova Scotia, Proceedings of Nova Scotia Institute of Science *XX*. Part 4: 177-288.

Hegi, Gustav. 1935. Illustrierte Flora von Mitteleuropa. *I*: 1-528. Carl Hanser, Verlag, Munich.

Lajoie, Paul G. 1960. Soil survey of Argenteuil, Two Mountains and Terrebonne Counties, Quebec. Res. Branch Can. Dept. of Agric., Queen's Printer, Ottawa, Ont.

Lincoln, F. C. 1950. Migration of Birds. Circular 16: 1-102. Fish and Wildlife Service, U.S. Dept. of Interior.

Löve A., and **Löve D.** 1956. Cytotaxonomical conspectus of the Icelandic flora. Acta Horti Gotoburgeniss. *XX*. No. 4: 65-291.

Montgomery, F. H. 1956. The introduced plants of Ontario growing outside of cultivation. Transactions of Royal Canadian Institute *XXXI*: 91-102.

Rebristaya, O. V., Skuortsov, A. K., Tolmachev, A. I., Tsvelev, N. N. and **Yurtsev, B. A.** 1964. Flora Arctica U.S.S.R. Fasc. II, Gramineae. Edited by A. I. Tolmachev. "Nauka", Moscow and Leningrad.

Taylor, Roy L. 1968. Long distance dispersal of seeds by pantcuffs. Canadian Field-Naturalist 82: no. 3, 221.

Received March 15, 1969
Accepted August 13, 1969

Notes

Claw-shuddering Behavior of the Shore Crab *Hemigrapsus oregonensis*

Abstract. During the reproductive season males of the green shore crab capture both females and other males when attempting to mate. Willing females stand passively while the males take up the copulatory position beneath them; unwilling females struggle until freed. Captured males perform a claw-shuddering movement which obtains their release. Claw-shuddering is detected by the captor probably through the tactile sense.

The common green shore crab *Hemigrapsus oregonensis* inhabits estuaries and protected waters from Alaska to the Gulf of California (Hart, 1968). It is active when covered by water which is often muddy, and it is also active at night (Symons, 1964). These conditions restrict its vision, and the crab appears to have adapted by becoming relatively independent of the visual sense. For instance, *H. oregonensis* does not respond to sight of food, but becomes active and feeds when it smells or touches it (Symons, 1964). The crab appears to use vision chiefly to avoid and defend itself against predators. Vision may play a minor role in reproductive behaviour but the following observations indicate that locating and identifying potential mates could take place in the absence of vision.

Events leading to copulatory attempts were frequently observed among these crabs held in aquaria containing a layer of sand and a few inches of sea water. Males captured potential mates with or without using vision. Visually directed capture was by rushing forward and seizing another crab between the claws. These rushes and grabbing movements occurred even when the two crabs were separated by a watertight transparent partition. Capture without vision occurred after a male walked onto another crab while sidling along the walls of the aquarium: when the male was on top, he simply clenched the carapace of the lower crab between his legs. Males captured both females and other males by these means.

Hard-shelled females which were willing to mate responded to capture by standing passively while the male oriented himself face to face or, if he was on top of her, head to tail. The normal mating posture was assumed from the latter position by the male backing over the front of the female's carapace (Figure 1A). In the copulatory position the male hung upside down beneath the female assuming the same position as does *Pachygrapsus crassipes* (Hiatt, 1948). Copulation lasted only 2 to 3 minutes which was shorter than for *P. crassipes*, but females were not examined to see whether sperm was transferred. Captured females which were unwilling to mate struggled until freed.

If the captured crab was another male, the captive performed a special movement with his claws which elicited his release. Males of some

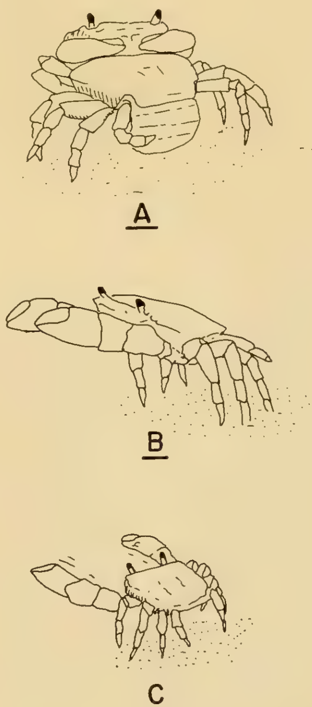


FIGURE 1. A. The male sliding over the front of a female to assume the copulatory position; B. The start of claw-shuddering by a male crab; C. The shuddering movement.

other species of crab are also unable to distinguish between males and females (Chidester, 1911), but in these species captured males escape only by struggling. A captured male *H. oregonensis* obtained release by rising on his legs and stretching forward with claws extended and together (Figure 1B). Then, without pausing, the captive moved his claws rapidly apart with a shuddering motion (Figure 1C). Repetition of the movement was seldom necessary to obtain release, the captor moving away immediately. Females were never observed to make this movement under any circumstances.

Two observations suggested that captors may have detected the claw-shuddering movement by tactile means rather than by vision. First, male crabs sometimes performed the claw-shuddering movement during the reproductive season in May if an observer held them by the carapace. When this occurred, the vibration of the shuddering motion was easily felt through the fingers. Second, crabs blinded with a coating of plastic aluminum over their eyes-stalks scuttled across the bottom and crowded against the walls of the aquarium when a small pebble was dropped into the water. Crabs, therefore, appeared capable of sensing vibratory stimuli such as that made by claw-shuddering. Because the observations on copulatory behaviour were incidental to other experiments (Symons, 1964), crabs were not blinded until the reproductive season had passed. Conclusive demonstration that claw-shuddering could be detected through touch alone was therefore not attempted.

At least two other crabs are known to use vibration as a means of communication. Both *Sesarma cumolpe* (Verwey, 1930), and *Uca pugilator* (Burkenroad, 1947; Dembowski, 1925) drum on the ground with their large chelipeds, apparently as a part of their reproductive behaviour. Burkenroad (1947) notes that drumming by *Uca* occured mostly at night when a visual display, claw-wave beckoning, was not performed. The claw-shuddering of *H. oregonensis* seems potentially well suited for communication at night in muddy water where visual stimuli would be ineffective.

Acknowledgements.

These observations were made while performing work under the direction of Paul A. Dehnel.

Literature Cited

Burkenroad, M. O. 1947. Production of sound by the fiddler crab, *Uca pugilator* Bosc., with remarks on its nocturnal and mating behaviour. Ecology 28: 458-462.

Chidester, F. E. 1911. The mating habits of four species of the Brachyura. Biol. Bull. 21: 235-248.

Dembowski, J. 1925. On the "speech" of the fiddler crab, *Uca pugilator*. Prace Inst. Nenckiego 3: 1-6.

Hart, J. F. L. 1968. Crab-like Anomura and Brachyura (Crustacea: Decapoda) from southeastern Alaska and Prince William Sound. Nat. Mus. Can. Nat. Hist. Pap. No. 38: 1-6.

Hiatt, R. W. 1948. The biology of the lined shore crab *Pachygrapsus crassipes* Randall. Pac. Sci. 2: 135-213.

Symons, P. E. K. 1964. Behavioural responses of the crab *Hemigrapsus oregonensis* to temperature, diurnal light variation and food stimuli. Ecology 45: 579-596.

Verwey, J. 1930. Einiges über die Biologie ostindischer Mangrove-krabben. Treubia 12: 169-261.

PHILIP E. K. SYMONS

Department of Zoology
University of British Columbia,
Vancouver, B.C.
Present Address:
Fisheries Research Board of Canada.
Biological Station,
St. Andrews, N.B.
Received November 4, 1969
Accepted December 26, 1969

A Summary of Vertebrate Collections in the New Brunswick Museum

The vertebrate collections of the New Brunswick Museum had their beginning when the Gesner Museum opend its doors to the public on April 5, 1842, at Saint John, N.B. Approximately 200 bird and 50 mammal specimens "of New Brunswick and Nova Scotia" were enumerated in Gesner's catalogue. In addition a number of foreign birds were on display. The collections of reptiles and fishes were small, with only a few species being mentioned. Many of the specimens have long since deteriorated and have been discarded, but it is interesting to note that a Black Bear, *Euarctos americanus*, one of the few original specimens left, is still on display in the New Brunswick Museum.

The Natural History Society of New Brunswick had its beginning in 1862; and the Gesner collec-

tion was housed in the Mechanics' Institute Museum, where the Society's meetings were held. There is little mention of additions to the vertebrate collection until 1880. When Montague Chamberlain, author of the first catalogue of Canadian birds, became chairman of the ornithological committee an attempt was made to develop a systematic collection. Under A. Gordon Leavitt, who was appointed chairman of the ornithological committee in 1897, many specimens of New Brunswick birds, both skins and mounts, were added to the collections. Mr. Leavitt's data for 608 specimens is still on file in the New Brunswick Museum.

Prior to 1900 a large collection of birds was made by George A. Boardman of Milltown, N.B. According to a letter from James Vroom of St. Stephen to Prof. L. W. Bailey of Fredericton, Mr. Boardman had the opportunity to sell certain specimens from his collection but preferred to keep it "unbroken" and felt that there were "men of liberality enough in New Brunswick to keep it within the Province" (letter of July 15, 1882, N.B. Museum Archives). The collection consisted of 1138 mounted specimens, 524 skins, 10 small cases and 3 large cases of mounted birds and 4 cases of birds eggs; the collection is now housed in the New Brunswick Museum. Unfortunately, many of the specimens are without data, but it appears the majority were collected in the St. Stephen, N.B.-Calais, Maine area. A few hundred are not North American species.

In 1969 the collection of birds in the New Brunswick Museum was catalogued, finally fulfilling a need expressed by Mr. Leavitt in 1902 (Bulletin of the Natural History Society of New Brunswick 20: 507). There are 1500 skins (of which over 370 have been added during the past four years) and approximately 1500 mounted specimens. The most noteworthy bird specimens in the New Brunswick Museum are: Eskimo Curlew, *Numenius borealis,* 4 specimens (2 skins, 2 mounts); Whooping Crane, *Grus americana,* 1 specimen (mount); Passenger Pigeon, *Ectopistes migratorius,* 4 specimens (1 skin, 3 mounts); Carolina Parakeet, *Conuropis carolinensis,* 3 specimens (1 skin, 2 mounts); Ivory-billed Woodpecker, *Campephilus principalis,* 4 specimens (3 skins, 1 mount). Most species of birds native to New Brunswick are on display in the gallery.

Up to 1965 there were only a few specimens of New Brunswick mammals in the collection. Now over 600 specimens (skins and skulls) are catalogued. In addition most of the mammals native to New Brunswick are on display in the gallery.

Over the past four years the collection of New Brunswick amphibians and reptiles has increased from about 50 lots to over 650, all having been catalogued. The lots vary from 1 to 25 specimens with all species known from New Brunswick represented. There is a small foreign collection of mainly Fiji frogs; also about 20 uncatalogued foreign lizards and snakes.

In 1965 about 35 lots of New Brunswick fishes were housed in the New Brunswick Museum. Since then this has increased to over 550 lots, varying from 1 to 50 specimens per lot. Most of the freshwater species are represented and the more common, small marine species.

STANLEY W. GORHAM

Natural Science Department,
New Brunswick Museum,
Saint John, N.B.
Received October 5, 1969
Accepted December 29, 1969

Aberrant Behaviour by a Dominant Male Black-Tailed Deer

Abstract. On June 9, 1963, the dominant buck of a group of six male black-tailed deer (*Odocoileus hemionus columbianus*), encountering a doe with two female fawns, attempted to add one of the fawns to his sub-dominant associates. This behavior was unusual and is believed to be aberrant.

While observing black-tailed deer (*Odocoileus hemionus columbianus*) I watched a display of unusual behavior by a dominant buck on June 9, 1963, within the Cedar Creek deer study area in Oregon. The study area is located in the Wilson River drainage of the Tillamook Burn, in the Coast Range of northwestern Oregon, about 29 km inland from the Pacific Ocean. Observations were made with the aid of a 60x spotting scope at a distance of about 366 m.

Observations

I was observing deer in the East Drainage system of the study area from a prominence outside

the enclosure for the purpose of locating newborn fawns. At 11:00 a.m. a maternal doe and her two fawns were located on an exposed ridge about 15 m above the small perennial stream in the drainage bottom. The doe was foraging while the fawns ran around her in a playful manner. Both fawns were females captured several days before and marked with ear-tags for individual identification.

As I scanned the adjacent area a group of six black-tailed bucks leaving the dense red alder (*Alnus rubra*) cover at the lower end of the drainage came into view about 46 m from the doe and her fawns. The males were led by the dominant animal, a large buck with three points in velvet on each antler. They moved in single file upgrade along the edge of the stream for about 30 m until the lead animal stopped. The following males stopped in place behind the lead male and then all looked at the alerted doe and playing fawns.

After several seconds the dominant male moved briskly up the ridge to a position about 7 m above the doe and the fawns. The five other bucks stood in place and watched. The doe and fawns turned their attention to the dominant male as he in turn seemingly evaluated the trio. The fawns were both within 3 m of the doe. Suddenly, the buck lowered his head and charged at the fawn which was closest to the doe, forcing it to turn and run downhill. The lead buck herded the fawn into a position in front of the standing string of males, then assumed his lead position in front of the fawn and resumed walking along the stream in an upgrade direction with the fawn and five bucks following.

The doe stood watching for several seconds, then charged down the hill at the group and passed through the line just behind the fawn. The fawn did not break pace, but kept moving with the males. The doe turned and charged past the fawn in an uphill direction, but the fawn continued to follow the dominant male. The doe turned and stood watching the group move about 15 m before she charged again. This time she struck the fawn on the right rump with her head in a nudging-like action. The fawn was knocked sideways, but regained its balance and ran back to its position in the group. On the fourth charge the doe headed straight at the left side of the fawn and the fawn broke from the line and ran uphill with the doe pursuing it. She herded the fawn up the ridge for about 60 m, stopped and turned to watch the bucks.

The dominant male and other males showed no concern over the loss of the fawn and continued moving up the drainage without stopping to look back. The doe stood watching the bucks for several minutes with the fawn by her side. They then returned to the next lower ridge where the second fawn was waiting. The doe resumed foraging and the fawns turned once again to their mutual play.

I conclude that an aberrant behavioral action was displayed. The behavior of the dominant male was unique because black-tailed bucks do not collect harems nor do they normally want or tolerate the close association of newborn fawns during the summer months.

Acknowledgements

I thank Dr. A. Kraemer, Department of Zoology, The University of Alberta for his help with the revision of the manuscript. Drs. C. Jonkel and A. H. Macpherson, Messrs. J. E. Bryant and G. D. Tessier, Canadian Wildlife Service, and Mr. R. H. Russell, Department of Zoology, The University of Alberta, kindly read the manuscript and provided critical comments and discussions. This work was carried out as part of a cooperative project of the Division of Wildlife Research, Oregon State Game Commission, the Oregon State Board of Forestry, and the Department of Fisheries and Wildlife, Oregon State University. Partially financed with Federal Aid to Restoration Funds under Pittman-Robertson Project W-51-R.

FRANK L. MILLER

Oregon State Game Commission,
Division of Wildlife Research,
Corvallis, Oregon.
Present Address:
Canadian Wildlife Service,
Eastern Region,
293 Albert Street,
Ottawa 4, Ontario.

Paronychia fastigiata (Caryophyllaceae), Forked Chickweed New to Ontario

A specimen collected in the Niagara Peninsula of Southern Ontario received for identification, proved to be Forked Chickweed, *Paronychia fastigiata* (Raf.) Fern. var. *fastigiata*, a species not previously known from Ontario.

Data are as follows: Ontario, Haldimand Co., Canborough Twp., Conc. 1, lot 17, south of Caistorville about one third of the distance to Canborough (about 9 miles NNW of Dunnville), on the property of the Niagara Conservation Authority, a small patch of less than a yard in diameter in scrubby woods on hard clay, August 21, 1969, *W. L. Putman 472*, (DAO).

The distribution of *P. fastigiata* var. *fastigiata* as given in Gray's Manual, Edition 8 (1950), is Mass. to Minn. s. to Fla. and Tex. In 1962, it was found in the railroad yards at Val Royal, Montreal by Mr. and Mrs. DuBoulay and reported (by C. Rousseau in Le Naturalist Canadien 95:49-169. 1968) as the first introduction of the species for Canada. The habitat of scrubby woods would seem to indicate a natural occurrence of the plant, but it is perhaps more likely a recent introduction.

Paronychia fastigiata is an annual or short-lived perennial. From *P. canadensis*, a rare native species which has not been collected in Ontario since 1901, and indeed may now no longer be a part of the flora, *P. fastigiata* can readily be separated by its more crowded inflorescence, puberulent stem, firmer oblanceolate to narrowly elliptic leaves and mucronulate tipped sepals.

W. J. CODY

Plant Research Institute
Central Experimental Farm
Ottawa 3, Ontario.
Received December 12, 1969
Accepted December 12, 1969

Townsend's Solitaire Collected at Brandon, Manitoba

On September 20, 1968, we collected a specimen of Townsend's Solitaire, *Myadestes townsendi*, in a back lane in central Brandon. The bird was feeding on the berries of a Virginia Creeper vine, *Parthenocissus inserta*, where it was detected by the junior author.

A subsequent search of available sources produced only one other collected specimen for Manitoba: Godfrey (1966) cites a record for the province at Stonewall, based on an immature male collected by G. C. Harrold (1923) on October 20, 1923. This specimen is in the Museum of Natural Sciences, National Museum of Canada, catalogue No. 19168.

Lawrence (1923) also reported the above data, noting that this was the first record for Manitoba. A second record was an authenticated sighting at Winnipeg by A. M. and J. Mackie on October 8 and 10, 1932, (Lawrence 1932). One other possible sighting was later listed by Lawrence (1951), a report by Oliver Calverley from the south end of Lake St. Martin in "early December", presumably in 1950.

The present specimen, an adult in healthy condition, sex undetermined, is in the B. J. Hales Museum of Natural History, Brandon University, catalogue No. B.U. 415.

The authors wish to acknowledge with thanks the data furnished through the efforts of H. Copland and R. W. Nero, both with the Museum of Man & Nature, Winnipeg, Man.

Literature Cited

Godfrey, W. Earl. 1966. "The Birds of Canada", National Museum of Canada, Bull. No. 203

Harrold, G. C. 1923. "Notes on some Interesting Species", Can. Field Nat. 37(9): 169

Lawrence, A. G. 1923. "Chickadee Notes", No. 137.

Lawrence, A. G. 1932. "Chickadee Notes", No. 603.

Lawrence, A. G. 1951. "Chickadee Notes", No. 1553.

J. LANE
D. RANDALL

1701 Lorne Ave., Brandon
561, 7th St., Brandon

A Record of a White-fronted Goose in New Brunswick

On November 7, 1968 an immature white-fronted goose, *Anser albifrons* (Scopoli), was shot at Washdemoak Lake, Queens County, New Brunswick. In addition, a white-fronted goose was taken on October 31, 1966 at Wilson's Point, Gloucester County (W.E. Godfrey, personnal communication). According to Squires (1952), only one

other specimen identified as this species can be referred to New Brunswick. In view of the preceding and the lack of any specimen or portion of a bird to document the previous occurrence of this goose in the province, it seems desirable to place the incident on record.

The writer wishes to thank W. E. Godfrey, Curator of Ornithology, National Museum of Canada, for his assistance in referring the latest specimen to the Greenland subspecies, *Anser albifrons flavirostris*. The head and neck, wings, and feet of the bird are on deposit with the Fish and Wildlife Branch, Department of Natural Resources, Fredericton, N.B.

Literature Cited

Squires, W. A. 1952. The birds of New Brunswick. The New Brunswick Mus., Monogr. Ser. No. 4. 164p.

JOHN C. BAIRD

Fish and Wildlife Branch
Department of Natural Resources
Fredericton, New Brunswick
Received April 8, 1969
Accepted August 13, 1969

Studies of the Byron Bog in Southwestern Ontario XLI. Distribution of Slugs and Snails (*Gastropoda*) in the Bog

Abstract. From May 8 to September, 1961 collections were made of *Lymnaea palustris, Planorbula armigera, Laevapex fuscus, Physa gyrina, Aplexa hypnorum, Stenotrema leai, Triodopsis albolabris, Retinella binneyana, Deroceras reticulatum, Anguispira alternata, Discus cronkhitei, Oxyloma retusa, Succinea avara* and *Cionella lubrica* in the bog. Observations on the distribution of these species in the zones of the bog are given.

During 1961, studies were undertaken on the non-insect invertebrates of the Byron Bog at London, Ontario, as part of a programme of studies sponsored by the National Museum of Canada. The Byron Bog and its vegetation zones have been described by Judd (1957).

In 1961 regular daily collections of invertebrates were made from May 8 to September 29 in the four different zones of the bog (Judd, 1957). These four zones are dry, wooded slopes (C); lower, damp, woods (B); open floating bog (A); and the open pond, Redmond's Pond (D). In zones A, B and C, plots were marked out with stakes, each plot 250 feet by 50 feet in size (Fig. 1, Judd, 1963). Each plot, in turn, was divided into five smaller sub-plots of dimensions 50 feet by 50 feet numbered from 1 to 5. Starting on May 8, collections were made in sub-plots numbered '1' in Zones A, B and C. The next day collections were made in sub-plots numbered '2'. This procedure was followed, in sequence, on successive days in plots numbered '3', '4', and '5'. This procedure, which was repeated throughout the summer, prevented daily disturbance of the population of animals in any one sub-plot. Invertebrates were searched for in soil and moss and under objects on the ground. Collections in Zone D, Redmond's Pond, were made daily by making three sweeps about three yards long through the water with a dip-net having a mouth 10 inches in diameter. Aquatic animals were collected with the dip-net in pools that were present in spring in Zones A, B and C.

Among the invertebrates collected were clams, slugs and snails. During the summer of 1961 Mr. M. S. Beverley aided in collecting and sorting specimens. All the clams were fingernail and pill clams (Sphaeriidae) and an account of their distribution in the bog is given by Judd (1966). Slugs, *Deroceras reticulatum*, were identified by the writer, *Laevapex fuscus* by A. H. Clarke, National Museum of Natural Sciences, Ottawa, *Oxyloma retusa* by F. W. Grimm, Baltimore, Maryland, and all other snails by Henry van der Schalie, Department of Zoology, University of Michigan. All specimens are deposited in the Department of Zoology, University of Western Ontario except specimens of *Laevapex fuscus* and *Oxyloma retusa* which are deposited in the National Museum of Natural Sciences, Ottawa. The numbers and distribution of the species in the zones of the bog are shown in Table I, arranged in order as in LaRocque (1953).

Account of Species Collected

Table I shows that fourteen species of slugs and snails were found in Zones B, C and D but none in A. Zone A is a floating mat of *Sphagnum* which is permanently soggy through the year but in which

the small temporary pools dry up early in the season. The most productive zone was C, yielding thirteen species and more than three-quarters of the total collection. Zone B yielded nine species, three of these typically aquatic and six terrestrial. Zone D, Redmond's Pond, yielded six species, five being aquatic species and one, *Oxyloma retusa*, being terrestrial and represented by a single specimen.

TABLE 1.
Distribution of slugs and snails in the bog

Species	Zones			
	B	C	D	Total
Lymnaea palustris	0	97	2	99
Planorbula armigera	116	25	20	161
Laevapex fuscus	0	0	3	3
Physa gyrina	9	27	2	38
Aplexa hypnorum	13	26	1	40
Stenotrema leai	0	3	0	3
Triodopsis albolabris	1	8	0	9
Retinella binneyana	4	27	0	31
Deroceras reticulatum	7	343	0	350
Anguispira alternata	0	41	0	41
Discus cronkhitei	1	14	0	15
Oxyloma retusa	9	71	1	81
Succinea avara	0	36	0	36
Cionella lubrica	3	4	0	7
Total	163	722	29	914

LYMNAEIDAE

Lymnaea palustris Mueller — 99 snails, May 10-August 25. Most of these were found in zone C before June 18 by which time temporary pools in which they were found on the lower slopes of Zone C were dried up. This species is circumboreal and found commonly throughout Canada (LaRocque, 1953).

PLANORBIDAE

Planorbula armigera Say — 161 snails, May 9 - September 9. Most of these were in Zone B where pools persisted through the season beneath the shade of trees. This species has been reported from Ontario by LaRocque (1953).

ANCYLIDAE

Laevapex fuscus Adams — 2, May 14; 1, July 16. These were found only in the permanent pond, Redmond's Pond, Zone D. LaRocque (1953) records that this species occurs from Massachusetts westward to the Mississippi valley.

PHYSIDAE

Physa gyrina Say — 38 snails, May 11 - September 29. Most of these were found in temporary pools on the lower slopes of Zone C before mid-June when the pools dried up. This species has been recorded from Ontario by LaRocque (1953).

Aplexa hypnorum L.—40 snails, May 8-August 25. Most of these were found in temporary pools on the lower slopes of Zone C before mid-June when the pools dried up. This species has been recorded from the northern United States and Canada by LaRocque (1953).

POLYGYRIDAE

Stenotrema leai Ward — 1 snail, July 15; 2 snails, August 28. These were all found in Zone C. Pilsbry (1939-1948) reports that this is a snail of damp places near water. It has been reported from Ontario by LaRocque (1953) and chiefly from the counties of Ontario touching Lake Erie (Oughton, 1948).

Triodopsis albolabris Say — 9 snails, May 29 - August 26. All but one were found on the wooded slopes of Zone C. This species is reported as a common snail in woodlands in southern Ontario by LaRocque (1953), Oughton (1948) and Pilsbry (1939-1948).

ZONITIDAE

Retinella binneyana Morse — 31 snails, May 14-September 29. Most of these were on the wooded slopes of Zone C. This species is reported from Ontario by LaRocque (1953), Oughton (1948) and Pilsbry (1939-1948), mainly from the northern part of the province.

LIMACIDAE

Deroceras reticulatum Mueller — 350 slugs, May 8 - September 29. This was the commonest mollusc found, occurring mainly beneath all manner of shelters on the ground in Zone C. LaRocque (1953), Oughton (1948) and Pilsbry (1939-1948) record it as a common field and garden slug, widespread in southern Ontario.

ENDODONTIDAE

Anguispira alternata Say — 41 snails, May 8 - September 15. These were all found under shelters

in Zone C. LaRocque (1953), Oughton (1948) and Pilsbry (1939-1948) record that this species is common in southern Ontario and found under loose bark, dead wood and stones.

Discus cronkhitei Newcomb — 15 snails, May 27 - August 29. Most of these were found in Zone C beneath shelters. LaRocque (1953) and Oughton (1948) record that this species occurs in Ontario, mainly in the Canadian and Transition Zones, and Pilsbry (1939-1948) reports that it lives in humid forest under dead wood and among rotting leaves.

SUCCINEIDAE

Oxyloma retusa (Lea) — 81 snails, May 13 - August 29. Most of these were found in Zone C. Oughton (1948) records this species from Ontario, most of his records being from the southern part of the province.

Succinea avara Say — 22 snails, May 8 - 14; 14 snails, August 2 - 25. These were found during two months, May and August, in Zone C. Possibly during the intervening months snails of this species were well up in the vegetation and were not noticed during the process of collecting on the ground. LaRocque (1953), Oughton (1948) and Pilsbry (1949-1948) record this species in Ontario.

CIONELLIDAE

Cionella lubrica Mueller — 7 snails, May 8 - August 26. The finding of this snail in Zones B and C is in accord with the report that it is found among the damp under-leaves in densely shaded places. LaRocque (1953) and Oughton (1948) record this species from Ontario and the lower Great Lakes region.

Literature Cited

Judd, W. W. 1957. Studies of the Byron Bog in southwestern Ontario I. Description of the bog. Canadian Entomologist, 89(5): 235-238.

Judd, W. W. 1963. Studies of the Byron Bog in southwestern Ontario XVI. Observations on the life cycle of two species of *Crangonyx* (Crustacea: Amphipoda). National Museum of Canada, Natural History Papers, No. 20.

Judd, W. W. 1966. Studies of the Byron Bog in southwestern Ontario XXIV. Distribution of fingernail and pill clams (Pelecypoda: Sphaeriidae). National Museum of Canada, Natural History Papers, No. 33.

LaRocque, A. 1953. Catalogue of the recent Mollusca of Canada. National Museum of Canada, Bulletin No. 129.

Oughton, J. 1948. A zoogeographical study of the land snails of Ontario. University of Toronto Studies, Biological Series, No. 57.

Pilsbry, H. A. 1939-1948. Land Mollusca of North America (north of Mexico). Academy of Natural Sciences of Philadelphia, Monograph 3, vols. 1 and 2.

WILLIAM W. JUDD

Department of Zoology,
University of Western Ontario,
London, Ontario.
Received June 28, 1969
Accepted July 5, 1969

Studies of the Byron Bog in Southwestern Ontario. XLII. Distribution of Mites (*Acarina*) in the Bog

Abstract. From May 8 to September, 1961 collecting in the bog yielded Erythraeidae, Calyptostomidae, Trombidiidae including *Allothrombium* and *Microtrombidium*, Hydrachnidae including *Hydrachna cruenta* and *H. rotunda*, Elyaidae including *Eylais extendens*, Hydryphantidae including *Thyas* sp. and *Euthyas* sp. and Pionidae including *Tiphys torris*. Observations on the seasonal distribution of the species in the zones of the bog are given.

In 1961 regular daily collections of invertebrates were made from May 8 to September 29 in the four zones of the Byron Bog. These four zones are wooded slopes (C), lower wooded region (B), open floating bog (A) and the open pond, Redmond's Pond (D) (Fig. 1, Judd, 1963a). Collections were made by M. S. Beverley following the procedure described by Judd (1963a). Among the specimens were 77 mites. Terrestrial mites (Erythraeidae, Calyptostomidae, Trombidiidae) were identified by Professor Marc André, Laboratoire d'Acarologie, Ecole des Hautes Etudes, LaVarenne, France and aquatic mites by Dr. R. M. Crowell, St. Lawrence University, Canton, New York. All specimens are deposited in the collection of the Department of Zoology, University of Western Ontario except some noted as "kept" by Dr. Crowell. Some have been stored in fluid in vials and

others are mounted on slides, and the slide numbers of these specimens are noted in the following account. The collection zones (A, B, C, D) and the dates of collection are also noted, each date representing one specimen unless otherwise indicated.

ERYTHRAEIDAE

May 25, C, Slide E32.29.

CALYPTOSTOMIDAE

July 14, C, E32.30.

TROMBIDIIDAE

Allothrombium sp. — female, May 24, A, E32.31.
Microtrombidum sp. — B: May 13 (E32.32), May 20 (E32.33), June 8 (E32.34); C: May 13 (E32.35, nymph), May 19 (E32.36), May 23 (E32.37), May 31 (E32.38), June 2 (E32.39, female), June 6 (E32.40), June 8 (E32.41), June 12 (E32.42, female), June 16 (E32.43), July 1 (E32.44), July 6 (E32.45), July 13 (E32.46), July 30 (E32.47).
Trombidiidae — June 1, C, E32.48, nymph.

HYDRACHNIDAE

Hydrachna cruenta Mueller var. *diminuata* Lundblad — June 6, D.
Hydrachna rotunda Marshall — June 20, D.
Hydrachna sp. — B: May 14, nymph (kept); D: May 8 (nymph), May 9 (nymph, kept), May 13 (nymph, kept), May 15, (2 nymphs), May 23 (2 males, 3 females), May 24 (8 females, 1 nymph), May 25 (2 kept), May 30 (4), May 31, June 1 (male), June 2 (2), June 3 (3), June 4 (3), June 6, June 8, June 9 (2), June 12, June 13, June 16, June 20, June 22 (kept).

EYLAIDAE

Eylais extendens (Mueller) — D: June 1 (E32.-49), June 11 (E32.50), June 18 (E32.51), June 20 (E32.52), June 23 (E32.53).
Eylais sp. — June 16, D, E32.54.

HYDRYPHANTIDAE

Thyas sp. May 8, A (kept).
Euthyas sp. — May 26, B.

PIONIDAE

Tiphys torris (Mueller) — B: May 29 (E32.55 female), June 3 (E.32.56).

Twenty mites in the typically terrestrial families, Erythraeidae, Calyptostomidae and Trombidiidae were collected. The majority were from the wooded slopes of the bog (Zone C) although *Allothrombium* sp. was found in the moss in the open bog (Zone A) and a few *Microtrombidium* were in the damp woods of Zone B. Baker and Wharton (1952) record that *Erythraeidae* occur in humus and among leaves, Calyptostomidae usually in very wet places and Trombidiidae in litter.

Fifty-seven mites of typically aquatic habit were collected. The majority were found in the permanent pond, Redmond's Pond (Zone D), and a few in pools beneath trees in Zone B in May and early June. *Hydrachna cruenta* has previously been reported from Ontario and *H. rotunda* from states of the United States adjacent to Ontario (Crowell, 1961). Nymphs of *Hydrachna* sp. predominated up to the end of May and adults thereafter. Lanciani (1969) reports that *H. cruenta* in particular attaches to corixid bugs, several species of which occur in the bog (Judd, 1963b). Crowell (1961) reports *Eylais extendens* from Ontario and Lanciani (1969) records that its larvae attach to larger corixids of the genus *Hesperocorixa,* two species of which are common in Redmond's Pond (Judd, 1963b). Various species of *Thyas* and *Euthyas* occur in states of the United States adjacent to Ontario and *Tiphys torris* has been reported from Canada (Crowell, 1961).

Literature Cited

Baker, E. W. and **Wharton, G. W.** 1952. An Introduction to Acarology. MacMillan Co. New York. 465 p.

Crowell, R. M. 1961. Catalogue of the distribution and ecological relationships of North American Hydracarina. Canadian Entomologist, 93: 321-359.

Judd, W. W. 1963a. Studies of the Byron Bog in southwestern Ontario XVI. Observations on the life cycles of two species of *Crangonyx* (Crustacea: Amphipoda). Natural History Papers, National Museum of Canada, No. 20.

————. 1963b. Studies of the Byron Bog in southwestern Ontario XVII. Seasonal distribution of Hemiptera (Corixidae, Notonectidae, Belostomatidae, Nepidae) in Redmond's Pond. Canadian Entomologist, 95: 1109-1111.

Lanciani, C. A. 1969. Three species of *Eylais* (Acari: Eylaidae) parasitic on aquatic Hemiptera. Transactions of the American Microscopical Society, 88: 356-365.

WILLIAM W. JUDD

Department of Zoology,
University of Western Ontario,
London, Ontario.

News and Comment

An Edmonton Chapter of the National and Provincial Parks Association

Last spring a group of ardent conservationists representing six organizations including the NPPAC held a public meeting on the proposed National park on the East Arm of Great Slave Lake. The response was good; action was needed to counterbalance the strong voice of the mining concerns. It was proposed that an Edmonton Chapter of the NPPAC be formed to deal with this and other such matters. J. C. Findlay was appointed chairman of the steering committee. In short we soon had formed a chapter with the understanding that we would broaden our terms of reference to include the following along with the general aims of the NPPAC.

—To maintain and improve the quality of our environment

—To promote a better understanding of our renewable and non-renewable natural resources

—To promote the development of ethical principles for land use and resource management.

—To aid in obtaining and communicating information on all natural resources and their management to enable the public and their governments to make better informed decisions on present and future environmental policies.

Although Edmonton is the first NPPAC chapter, groups in Lethbridge, Calgary and Winnipeg are proceeding towards Chapter status.

An interm executive was elected: Chairman, Mr. Ken Lazenby; Vice-chairmen, Mr. Ian Mercer; Secretary, Mrs. Cathy Gale; Treasurer, Mrs. P. Brown; Information and Newsletter Editor, Mr. Robert Morris; Project Chairman, Mr. Peter Kevan; Membership, Mr. D. Grey; Publicity, Mrs. Dianne Hayley.

The Great Slave issue was still alive however. On June 24, 1969, a public hearing, sponsored by the Department of Indian Affairs and Northern Development, was held in Yellowknife, NWT. Peter Kevan presented a brief on our behalf at this meeting and then attended the ensuing meeting in Snowdrift, NWT. (see report by Kevan, elsewhere in this issue).

Since June we have had a very informative meeting on strip mining, a pressing problem in Alberta's wilderness areas. We also had a very lively panel debate on the proper function of parks at the National and the Provincial levels. The various points of view were expressed by a professional biologist, an economist, a geographer, a sociologist, a member of the Canadian Wildlife Service, a representative of the Fish and Game Association, and a member of the Chamber of Commerce. In our latest business meeting we decided to incorporate as an Edmonton group while still remaining part of the NPPAC. It is our sincere hope that this arrangement will be compatable and enlightening to both parties.

We have an active agenda for the new year and hope to be able to contribute significantly to the development of sound conservation practices, particularly in the area of general enlightenment. We will continue to publish a short newsletter to announce meetings and keep our membership enformed of the activities of the Edmonton Chapter.

Mrs. Dianne Hayley

Okanagan-Similkameen Parks Society Achieves an Objective

The Newsletter of January, 1970, of the OSPS contains a story that demonstrates an implicit and clear understanding of political reality by the members of the society. At a public meeting of the society held on December 4, at the Penticton Art Centre, Mr. Robert Ahrens, Director, Provincial Parks Branch stated that "But for the Okanagan-Similkameen Parks Society, there would be no Cathedral Provincial Park."—and, "At one time there were 800 letters on Premier W. A. C. Bennett's desk." Thus a "Class A" Provincial Park was established.

Membership in the society increased by one-third in 1969. The government supplied the society with fencing for a Bighorn Sheep range that the society purchased several years ago (see the Canadian Field-Naturalist 82:55-57, 1968). They are now trying to enlarge the Cathedral Provincial Park, to urge the government to establish a Class A park on Okanagan Mountain so that the alpine meadows are protected. Also they are urging the

government to set aside a unique arid biotic area near Osoyoos. This last project will be of very special interest to biologists because of the many hundreds of species of plants and animals that occur only at this spot in Canada (although their ranges extend into the United States). The Newsletter also contained the following interesting paragraph:

"Arrangements have been made to hold our Annual Meeting at 8 p.m., April 28, 1970 at the Peach Bowl, Penticton, B.C. Please plan to attend and bring your friends. And write, write, write letters . . . . Do you really think there should be drilling for oil in the Gulf of Georgia? Should they be allowed to go ahead with the Ross Dam? Is the outdoor TV program KLAHANIE really going off the air? Do we really need a pulp Mill in the Armstrong-Enderly area? Letters from individuals do count . . . . remember the 800 letters on Mr. Bennett's desk and what came of this at Cathedral Lakes!

—Small wonder that membership went up by one-third in 1969! The address of the Society is Box 787, Summerland, B.C. and dues are: Individual $2.00; Husband and Wife, $3.00; Organization, $5.00. All donations above membership fees are income tax deductible.

—Editor.

Hinterland Who's Who

The Canadian Wildlife Service has started an attractive new series of 4 or 6 page, 8½ × 11 pamphlets entitled "Hinterland Who's Who." Each pamphlet describes a single species of animal or bird of Canada and includes information on life history, range, food, migration, travel, behavior, parasites and diseases, management and other characteristics. The text is written by various specialists; each pamphlet includes a map outlining breeding range or wintering range as applicable. The species out to date are Mallard, Mountain Sheep, Chipmunk, Grouse, Caribou, Red Fox, Black Bear, White-tailed deer, Bats, Whooping Crane, Canada Goose and Herring Gull. They are especially suitable for school use. Printed by the Queen's Printer, Ottawa, they are available by writing to the Canadian Wildlife Service, Department of Indian Affairs and Northern Development, Ottawa.

A National Park for the Northwest Territories—Continued

As a result of my previous efforts in support of the proposed National Park on the East Arm of Great Slave Lake and Artillery Lake on the Edge of the Barrens (Kevan and Evernden, 1969) I was awarded the task of presenting a brief for the National and Provincial Parks Association of Canada at the public hearings held in Yellowknife on 24 June, 1969.

The meeting was chaired by Mr. John Parker, the Deputy Commissioner of the NWT, and attended by 70 people. At the outset John Gordon, Assistant Deputy Minister of the Department of Indian Affairs and Northern Development (DIAND) outlined the content of the bulletin describing the proposed park and explained the 'Core' and 'Reserve' concepts (see Kevan and Evernden, 1969). Mr. Gordon stated that mineral resources hold the highest priority in developing the area, but that no substantial lodes have been discovered in over 30 years of exploration. There are some mineralizations associated with the Murky fault running parallel to the famed Macdonald fault, but these lie outside the proposed boundaries. Geologists from DIAND and the NWT Chamber of Mines were not in agreement as to the location of minerals.

Other mineralizations have been discovered well to the southeast, and these are at the root of problems on rights to hydro-electric power and access within the proposed park. The Lockhart River (spectacular enough in its own right to warrant a park) has a hydro-electric power potential of 281 megawatts. At present there is more than enough power potential in already existing sites, some of which could easily double their output; yet the NWT Chamber of Mines insists that the Lockhart River be available for power. Mr. Gordon had the power to concede the Tyrell Falls. A very alarming concession. The Chamber of Mines also insists on access routes through the proposed park. These, if limited and strictly regulated, would probably be beneficial. Mr. N. Byrne, President of the NWT Chamber of Mines, summarized his views with the outlandish assertion that the proposed park "nullifies the God-given assets" of the area.

It was evident that many people at the meeting, particularly Mr. T. Godfrey of the Yukon and B.C. Chamber of Mines, and others in the mining

fraternity fail to realize or understand the intent of National Parks as unique natural museums for the future use of all Canadians. They recommended that DIAND improve other National Parks, notably Wood Buffalo, and criticized DIAND for proposing parks in remote areas where people could not use them.

Although the meeting yielded very little immediate action, it served as an excellent sounding board, giving each side chances to examine the others' attitudes and stands. I think those in favour of the proposed park won substantial ground as no less than 15 briefs, letters, and telegrams in support arrived from across Canada.

The next day I was kindly permitted to fly over the proposed park area and to visit Snowdrift to attend the talks with Chief Pierre Catholique and his people with DIAND officials. The people in Snowdrift were not in favour of the proposed park, and would rather have mining interests nearby to provide work. Employment worries ranked high in the discussions, and the people were assured that the new park would provide work. Concerns were also aired about the possible loss of hunting and trapping rights as guaranteed by Treaties 8 and 11. DIAND has since incorporated these rights into the park proposal.

It is important for this proposed park to make the most of all the assets it encompasses. This includes benefits to and from the people of the area. Who, if not the inhabitants knows the country better or are better equipped with first-hand knowledge to understand the intricacies of the land and to share with others through teaching this fund of information? By employing and training the people of Snowdrift as wardens, naturalists, and guides, the proposed park will surely gain in every way, having as its guardians its own people.

On 24 February, 1970 I read in the Edmonton Journal that DIAND may concede about 2,000 square miles of the proposed park to mining interests. This has come about because of the discovery of uranium, nickel and copper deposits. Already 3,000 claims have been staked, and of these; 300 are within the proposed park boundaries. Everyone who cares for this unique opportunity to create a magnificent park on the Edge of the Barrens must surely move to prevent the continuation of the scorched-earth policy on the East Arm of Great Slave Lake.

Already rumours and implications are starting that DIAND will or should abandon the Great Slave Lake proposal and divert its attention to the Nahanni Valley in the N.W.T., or to an Arctic Island park. Suffice it to say that all the above areas are unique and warrent parks, and that it is impossible to barter one against the other if the well-rounded and representative system of National Parks as envisaged by The Hon. Mr. Jean Chretien and DIAND is to become reality.

Literature Cited

Kevan, P. G. and **L. N. Evernden,** 1969. A National Park for the Northwest Territories — The East Arm of Great Slave Lake and Artillery Lake. Can. Field-Nat. 83: 169-172.

Sorensen, A. 1970. Claims staked in the proposed N.W.T. park. The Edmonton Journal, 24 February, 1970, p.l.

Proposed National Park. Great Slave Lake. Bulletin by National Parks Service — Planning Department of Indian Affairs and Northern Development. January 1969. 16 pp. + map.

Treaty No. 8 made June 21, 1899 and Adhesions, Reports, etc., Reprinted 1957, Queen's Printer and Controller of Stationery, Ottawa. 24 pp. + map.

Treaty No. 11 (June 27, 1921) and Adhesion (July 17, 1922) with Reports, etc. Reprinted 1926 edition 1967, Queen's Printer and Controller of Stationery, Ottawa. 12pp. + map.

PETER G. KEVAN,

Department of Entomology,
University of Alberta,
Edmonton, Alberta
November, 1969

Letters

A Letter from the Yukon

"Canada has been called a storehouse of limitless natural wealth. The lid of this great treasurechest is Canada's North. This lid is slowly being pried open and the abundance of natural resources that is being revealed is staggering.
Mountains of iron ore, rich new veins of silver lead and zinc and tungsten are being discovered. Copper seekers are swarming over the barren hills and plains of the Coppermine River. Oil and gas explorers are surging up the MacKenzie Valley and over the frozen seas to the Arctic Islands. Every facility is being strained as men and machines move North. The potential of the Canadian North is barely known but it is now obvious that it is rich beyond belief."

How does this sound to you, a naturalist or biologist and therefore, we hope, someone who feels deeply about the land and not just the minerals? It is a verbatim quote from a 1969 statement by the Federal Minister of Industry, Trade and Commerce.

To those of us who have called the North our home for a long time and who see in the North something more than an area to be exploited and then abandoned, the philosophy that seems to be at the root of such statements must be challenged forcefully if we wish to preserve even a measure of the now existing environmental quality and grandeur in that land "North of 60", not only for the local people, both indigenous and white but for Canada and the world as a whole.

To date however, practically nothing stands in the way of the "developers" and promoters to come in with their bulldozers, explosives, drills, chainsaws and attitudes to match, to do as they please. In the remote Northern hinterland, in the sacred name of "progress" ecological crimes may be committed that even local people, let alone the outside world hardly learn about.

Whose responsibility is it to ensure that "development" in the North is going to be just that, and not mere resource extraction which is synonymous with despoilation and ruin as it always has been elsewhere? Who will protect the *land* and ensure that development here will be weighed against the demands of rational environmental practices and planning?—The Indian and Eskimo people of the Yukon and N.W.T. who, make no mistake, deeply resent the desecration of their homeland and way of life by technological arrogance but who, by their nature, are not vocal?—A handful of comparative newcomers who love this Northland, have taken solid root in it and desperately want to prevent a repeat of the ecological tragedies taking place to their South?—Or ALL of the Canadian public, including you?

After all, the Federal Government's stated policy is that "the natural resources of the Yukon and N.W.T. belong to ALL Canadians and are being developed for all of Canada". Judging by the brisk trade in Northern mining stocks in Toronto and Vancouver, many Canadians appear to be aware that "their" North is being "developed" and they are quick to cash in on the profits. But most of them do not even know the *land* where this "development" takes place so why should they be concerned *how* it takes place or whether it is pure rape, as long as they make money?

In the Yukon, virtually nothing stops environmental destruction by resource exploitation. The land lies wide open for technological assault. No laws regulate destruction of wildlife habitat, water quality or aesthetic values of environment. Hunting regulations are uniform for all of the Territory's 207,000 square miles, an incongruity. A game census has never been taken and there is no scientific basis for these "regulations" yet there is a year around wolf-bounty, a wolf poisoning program and, as an example, a 4 week cowmoose season which runs concurrent with the bull moose season. There are no Parks, there is no land classification, the list is depressing . . . and almost endless.

Lately the Department of Indian Affairs and Northern Development (DIAND) which singlehanded is responsible in every respect for the Yukon and N.W.T. has shown some signs of becoming aware of the situation. "Land-use" regulations are being formulated in an attempt to create some measure of orderliness in the "use" of unoccupied Crown lands. They do not specify nor clearly acknowledge that there are situations in which non-use is indicated and they do not come to grips with what the exploiters can do (and are doing) to the thousands of square miles that are taken up in mineral claims and which are the locations where environmental ruination reaches its worst proportions.

There are regulations in the making for the preservation of water quality in the North. But

Yukon River valley near mouth of White River still a quality environment — for how long . . . ?

no research is being done on the effect of extreme winter temperatures on the only form of mine-waste disposal used in the North, namely tailingsponds which for their effectiveness depend on water remaining in the liquid state—somewhat problematic during a 6-7 month winter . . . It is becoming alarmingly clear that conventional tailingsponds do not work in the North. And any regulations, in the absence of an efficient enforcement apparatus, will be mere windowdressing. Signs of the establishment of such an apparatus are nowhere to be seen . . .

Really, these facts need not be related here. They are quite well known by government departments and their officials, resource engineers and even by many politicians. The Canadian Wildlife Service is especially familiar with the situation and recognizes the dangers; unfortunately it is tucked away in a corner of a department with the stated purpose of development and use of the Northern environment.

But the great mass of the public does not know or understand and, more than anything else, public opinion (expressed) is needed as a counter-weight to short-term Northern exploitation.

The Yukon Conservation Society was incorporated in April 1968 by a handful of concerned Yukoners with precisely that in mind — to help inform the thinking public in the Yukon, the provinces and the U.S.A. of "the other side" of the present "development" picture in the North and issue warning on what the continent stands to lose.

It is an often dismal and seemingly hopeless task in a Territory the size of a prairie-province but with less than 20,000 inhabitants and an almost complete absence of rural population. The only sizeable community is Whitehorse, with over half of the territory's population and with a philosophy of practically complete commitment to industrial expansion and quick monetary gain through natural resource exploitation. Whitehorse also controls all of the territory's opinion forming and news-giving media . . .

The Society has had some success in making both local and federal government aware that a watchful eye is being kept which probably results

in some action here and there, and there are signs that local concern may be on the increase. But a large part of the population is made up of people who stay 2 or 3 years only and by those who feel that, in a resource-oriented society, their livelihood will be in jeopardy if they become vocal hence it is dubious whether the Society will ever be a match for the vociferous exploiter's lobby.

It is obvious that the Y.C.S. can be an "early distant warning" system but that, to be effective, it will have to rely more on how well its signals will be heeded by Canadians in the rest of Canada than by the elusive minority called Yukoners.

The Society is as yet weak and poor. Its biggest sticks are its voluminous fact-presenting correspondence with government departments and officials and its twice-yearly NEWSLETTER which simultaneously serves as the cement between members in a vast area where communications are difficult and costly, an opinion-gathering medium (using questionnaires) and a listing of developments and issues pertaining to the present environmental crisis in the Yukon. The Newsletter attempts to speak out ". . . not by wholesale indictment of complete industries or groups but by diligently and objectively gathering facts without personal prejudice, dishonesty or evasion and by not shrinking from controversy where controversy is needed to save the land we love . . ."

What the Society needs desperately is your expression of concern for and interest in what is happening in the North, YOUR North. Our Newsletter can inform you of the issues and, to be effective, it should speak with a strong voice and be read widely, much more widely than we can afford to have it read now.

Without your help we cannot survive for long.

If you are a Canadian, it is your country, your land and your people that are at stake. If you are an American citizen, remember that once your land was as pure and untrammeled as this North which now is the last remaining large wilderness on this continent.

JOHN LAMMERS, President

Yukon Conservation Society
P.O. Box 1063
Whitehorse, Yukon
January, 1970

Yukon Conservation Society

Established March 7, 1968.

Incorporated as a registered Society under the Yukon Society Ordinance.

Objects of the Society:
"To secure the wise use, protection or preservation of scenic, recreational, educational, wildlife and wilderness values of Yukon Territory".

Publications: Y.C.S. Newsletter, twice-yearly at present but more frequently as funds become available.

Memberships (all including subscription to the Newsletter):
Regular voting (Yukon residents only $3.00/year
Associate member (non-voting, non-resident) 2.00/year
Student (non-voting) under 19 years of age 1.00/year

Address: Post Office Box 1063,
WHITEHORSE, Yukon.

Reviews

Pond Life. A Guide to Common Plants and Animals of North American Ponds and Lakes

By George K. Reid. Illustrated by Sally D. Kaicher and Tom Dolan. Golden Press, New York. 160 pp. 486 illus. in color. 1967. $1.25 (US)

This beautifully illustrated well-organized little book in a plasticized paper cover contains basic simplified information on the plant and animal life of wetlands, ponds, and lakes of the North American continent. It concisely describes the principal kinds of aquatic plant and animal life; the taxonomic units range from unicellular algae and bacteria to the vascular plants, from protozoans, sponges and annelid worms to arthropods, mollusks and other invertebrate animals, and from fishes, amphibians and reptiles to birds and mammals among the vertebrates. Various types of ponds (bog, farm, alpine) are described and compared, and contrasted with true lakes. Explanations of water characteristics such as density changes, heat-holding capacity, the O_2 — CO_2 cycle, solution of minerals, and the temperature cycle of lakes are remarkably concise and clear. Thumb-nail accounts of community composition and their relationship to the surface film, open water, bottom and littoral habitats are given. The amateur collector will value the advice on how to study organisms in their natural surroundings and admire the concise pictorial descriptions of aquatic nets, waterscopes, plant hooks, killing jars and other collecting equipment.

Considering the smaller-than-penny size of most, the color rendition and register of the illustrations is remarkably good. The art work is most accurate and most life-like in the illustrations of higher plants, insects and mollusks, and the vertebrates, especially the turtles. The primitive plants and animals and some of the crustaceans are less accurately depicted. Thus, amphipods are shown with only two pairs of uropods rather than three, and the first and second walking legs of some crayfish lack pincers.

The author has given about equal space to plants, invertebrates, and vertebrates, and thereby may have created an erroneous impression of the relative importance of the higher animals which are, of course, vastly outnumbered by both species and individuals of invertebrates. The reader might well wonder why the proboscis worm, represented by only a single North American fresh-water species, is awarded half a page, whereas the clams and snails, with many common and ecologically important species, are restricted to four pages, and the mysid shrimps, widespread in Canadian lakes and in coastal brackish lakes, are not treated at all.

The text is relatively error-free and mechanical oversights are minimal. However, on p. 103 the reader is informed (correctly) that the water scorpion (*Ranatra*) lives submerged and breathes by means of a 'snorkel tail'; yet on p. 17 this animal is depicted like a water strider (*Gerris*) resting on the surface film! The author should know that copepods have 6 copepodite as well as 6 naupliar stages, and that most amphipods are not able to jump when out of the water (only some Talitroidea do). Naturalists who have studied the beautiful 3-volume series on Odonata by the late Professor E. M. Walker of Toronto migh not agree with Reid's over-simplified statements that "most dragonflies . . . are identified only in the adult stage" and "nymphs of all species are much alike in appearance". On p. 114 the author (a biologist) has lapsed in distinguishing birds from mammals when he meant mammals for the latter! Elsewhere he infers that the glochidium larva is common to the life cycle of all fresh-water bivalves when in fact the finger nail clams (Sphaeriidae) are viviparous and *Rangia* has a veliger.

At a time when pollution seriously threatens our aquatic wildlife heritage, every naturalist should be aware of what is ours to protect and enjoy. This Golden Nature Guide on Pond Life should therefore be in everyone's library. At the price, one can scarcely afford not to have it!

E. L. Bousfield

National Museum of Natural Sciences,
Ottawa, Ontario.

The Caecilians of the World: A Taxonomic Review

By Dr. Edward Harrison Taylor, 1968. University of Kansas Press, Lawrence; 848 pp., 421 figs. Available in Canada from Burns and MacEachern Limited, 62 Railside Road, Don Mills, Ontario. $28.50.

In the Class Amphibia (amphibians) probably the least known of the three orders is Gymnophiona, the limbless caecilians of the tropical and sub-tropical regions of the world. The order Caudata (salamanders) and order Anura (frogs) are, of course, much better known. Caecilians

superficially resemble large earthworms and most species live in much the same habitat, burrowing in the moist earth. Consequently they are very secretive and difficult to collect. A few species are aquatic, living in freshwater streams and rivers. Dr. Taylor's new work adds greatly to the knowledge of the order Gymnophiona.

Taylor's 1968 work which contains an introduction of 43 pages, takes into consideration the following topics: "purpose and methods; history of the development of knowledge of caecilians in the taxonomic system; characters used for family, genus and species; life histories; habitats; predators; food; distribution; fossil records; primitive characters; family concepts; family and generic criteria; and areas for exploration". The remainder of the book, over 750 pages, is devoted to a taxonomic treatment of the caecilians of the world. In this section keys with descriptions of families and genera are given. For the species and subspecies, photographs of preserved specimens, drawings and sometimes X-rays accompany the keys and descriptions. There is also an excellent bibliography, but Taylor points out that he has made "no exhaustive search for anatomical papers".

Prior to 1959 one family, 17 genera and 75 species of caecilians were recognized. Since that time 13 new genera and 60 new species have been described by Taylor. In his 1968 work presently under review, 3 families, 34 genera and 166 species and subspecies are recognized. (In comparison Peters (1879) recognized 11 genera, 31 species; Boulenger (1882) 11 genera, 32 species; Nieden (1913) 19 genera, 50 species and Gorham (1962) 18 genera, 97 species).

There are several quotations from Taylor's work which should be mentioned. He states (p. 1) "the number of species known from one or two specimens is remarkable". When more material becomes available for comparison perhaps not all the species described by Taylor will stand the test of time. However, further research is at present the only answer. Taylor also states that owing to the "cost of paper and printing" not all the references are quoted in the synonymy of the species, and for the same reason (p. 3) it was not possible to "list all the specimens studied or even to record all the data taken on the specimens studied". This may make matters difficult for future workers. Taylor states (p. 1) "pictures are perhaps the only universal language". This is commendable. In some cases it is unfortunate that the reproduction of the text figures is not the best.

Not all herpetologists have been in agreement with Taylor in regard to some species of caecilians which he has described from the Philippines and Borneo. A critical review of Taylor's 1968 work appeared in Copeia, 1969: 216-219.

It should be noted that Dr. Taylor has seen more caecilians in the field, examined more specimens than any other herpetologist, and his comprehensive and indispensable monograph will very likely remain the basis for further study of the caecilians of the world for some time to come. For the reference library, and for anyone seriously interested in caecilians, this book is undoubtedly well worth the quoted price.

Stanley W. Gorham

Natural Science Department
New Brunswick Museum
Saint John, N.B.

Checklist of Canadian Freshwater Fishes with Keys for Identification

By W. B. Scott and E. J. Crossman. Royal Ontario Museum Life Sciences Miscellaneous Publication. Toronto. 104 pp., 3 figures, map. 1969. $1.50.

This booklet lists the English common and scientific names with provinces of occurrence for those 183 species in 23 families known in the fresh waters of Canada (with Alaska being annexed as a Canadian province). This is about the same number of species as listed by Scott (1958, *A checklist of the freshwater fishes of Canada and Alaska*), subsequent additions having been counterbalanced by deletions. Species are listed alphabetically within families arranged in a modified Berg ordinal classification. Subspecies are not listed but are sometimes, when distinctive, mentioned under the species. The classification tends to be somewhat conservative.

Artificial keys to the identification of families and species are presented. No keys are given for species of the subgenus *Leucichthys*. Several characters are usually given in the English and/or metric system. Several specimens were run through the keys successfully.

A list of "Species of doubtful occurrence" is appended; this includes marine species sporadically entering freshwaters. The number of species is given for each province, territory, and watershed. This is followed by a list of species known in the Atlantic, Hudson Bay, Arctic, Pacific and Gulf of Mexico watersheds. It would have been useful to present the number of native species in addition to the total number of species in these categories.

Asterisks denote introduced species in the watershed lists, although they have been accidentally omitted for species such as *Cyprinus carpio* and *Carassius auratus* in the Gulf of Mexico watershed. A Literature Cited section and an index complete the paper. It is regrettable that common names in French were not included. Typographical errors are few. The publication is printed on good quality, non-glossy paper that should stand up to hard use.

The only previous extensive keys to Canadian freshwater fishes were by Dymond (1947, *A list of the freshwater fishes of Eastern Canada with keys*) which omitted western Canada and is now considerably out of date and by Slastenenko (1958, *The freshwater fishes of Canada*) which is also out of date and which suffered from many inaccuracies. Other publications, essentially American, have covered Canadian fishes to a greater or lesser extent, but omitted certain species and included extralimital species which necessitated the time-consuming separation of forms not found in Canada. As an up-to-date list of English common and scientific names and provincial distributions of and keys to Canadian freshwater fishes, this publication will be highly useful to students, fishery biologists, and ichthyologists. There is no doubt that this publication is an important contribution to Canadian ichthyology.

D. E. McALLISTER

National Museum of Natural Sciences,
Ottawa, Ontario.

Flore de l'Anticosti-Minganie

By Frère Marie-Victorin, é.c. and Frère Rolland-Germain, é.c., 1969. Les Presses de l'Université de Montréal, C.P. 6128, Montreal 101. 529 pp. $13.00.

The flora of the region adjacent to the Gulf of St. Lawrence has attracted considerable attention, particularly by M. L. Fernald and students of the Montreal school. Here is a treatment of one large island, Anticosti, and the Mingan Islands, an archipelago which lies adjacent to the shore of the gulf, north of Anticosti.

The book is divided into four sections. The first consists of a description of the area, its history, notes on geography, geology and previous botanical work.

The second, and by far the most interesting and important section, is the daily journal which covers the collecting seasons of 1917, 1924, 1925, 1927, and 1928. This journal presents a wealth of information not only on the plants found and their ecology, but also on geology, geography, weather and many other facets which caught the interest of the visitors during their explorations. This section was completed by Frère Marie-Victorin before his untimely death in 1944. It is unfortunate that publication had to wait until 1969, twenty-five years later.

The third part is a citation of specimens collected from the various islands, not only by the authors but by earlier botanists as well. This work was begun by Victorin and completed by Frère Rolland-Germain.

Part four is a discussion of approximately 80 taxa which make up the "florule allogène de l'Anticosti-Minganie" — endemics or plants of special phytogeographic interest which do not form a part of the common hudsonian or laurentian flora. One new hybrid, *Arctostaphylos* × *victorinii* Rolland-Germain, is described and the transfer *Cypripedium calceolus* var. *rupestre* (Vict. & Rousseau) Rolland-German is made. This section was planned by Victorin, but is primarily the work of Rolland-Germain. Comments on nomenclature and treatment of the taxa by other authors are, with seven exceptions, no more recent than 1950, and the most recent is 1957. It would thus appear that the manuscript was ready for publication at least ten years before it finally reached book form!

A bibliography and index complete the book. The text is written in french.

W. J. CODY

Plant Research Institute
Central Experimental Farm
Ottawa 3, Ontario

Other New Titles

Practical Guide to Synthetic Detergent Formulation and Production.

A. Davidson and B. M. Milwidsky. Scientific Review, 1968. "Emphasis is placed on the sulfonate and ethoxylate surfactants, which the small or medium sized manufacturer can most readily attempt to produce on his own. The full range of manufacturing operations is shown, followed by discussion of a large number of formulations that can be readily developed or adapted to suit the reader's specialized marketing requirements". (The advertisement said nothing of pollution).

Fallout on the Farm. Blueprint for Survival No. 3

Canada Department of Agriculture Publication 1208, 25 pp. "The bulletin provides farmers and agricul-

turists with information about radioactive fallout. It explains the effect of fallout and suggests how the hazard can be minimized".

Ontario Snakes. Barbara Froom. Conservation Information Section Department of Lands and Forests, Toronto, Ont. 1967. 36p. Illus. Gives commentary and photographs of each of Ontario's 15 species of snakes.

Wolves and Coyotes in Ontario. Department of Lands and Forests, Toronto, Ont. (no date). 15p. An attractive pamphlet describing the lives of these two species in a friendly way.

Great Slave Lake-South Shore; An Economic Survey. D. Radojicic. Edited by G. Anders. Industrial Division, Department of Indian Affairs and Northern Development, Ottawa 1967. Illus. 128p.

Strategies of American Water Management. G. F. White, University of Michigan Press, Ann Arbor, 1969, 155p. $5.95 (US).

A Bibliography of Books on the Environment—Air, Water and Solid Wastes. G. F. Bennett and J. W. Hostman. Research Foundation, University of Toledo, Toledo, Ohio, 1969. 54p. Paperback. $2. (US).

Habits and Territories. A Study of the Use of Space by Animals. Peter H. Klopfer. Basic Books, New York, 1969. Illus. 118p. Basic Topics in Comparative Psychology. $3.95 (US).

The Hungry Future. René Dumont and Bernard Rosier. Translated from the French by Rosamund Linell and R. B. Sutcliffe. Praeger, New York, 1969. Illus. 272p. $6.95 (US).

Picture Atlas of the Artic. R. Thorén. Elsevier, New York, 1969. 452p. $57.50 (US).

Canadian Museums and Related Institutions. A hard cover listing of Canadian Institutions categorized by subject and Province for easy reference. Available from Canadian Museums, Association, 505 Hydro Electric Building, 56 Sparks St., Ottawa 4, Canada.

The Dynamics of Canadian Arctic Fox Populations. A. H. Macpherson, Canadian Wildlife Service Report Series No. 8, Department of Indian Affairs and Northern Development, Ottawa, 1969. 52pp. Illus. Paperback $1.00.

Population Estimate and Distribution of Barren-ground Caribou in Mackenzie District, N.W.T., Saskatchewan and Alberta. Donald C. Thomas, Canadian Wildlife Service Report Series, No. 9. Department of Indian Affairs and Northern Development, Ottawa 1969, 44pp. Illus. Paperback $1.00.

Common Edible Mushrooms. Clyde M. Christensen. Univ. of Minnesota Press, Minneapolis, 1969. 126pp. Illus. Reprint of 1943 edition. Cloth, $4.50; Paperback $2.45 (US).

Animal Life of Europe: the Naturalist's Reference Book. Jakob Graf. Transl. from the German edition (Munich, 1961) by Pamela and Maurice Michael. Warne, New York, 1968. 596 p. Illus. $15.00 (US).

Cactus-feeding Insects and Mites. John Mann. U.S. National Museum Bulletin 256. Smithsonian Inst. Press, Washington, D.C. Illus. 160p. Paperback $1.25 (US). From Superintendent of Documents, Washington, D.C.

Notes and Comments on Vertabrate Paleontology. Alfred S. Romer. Univ. of Chicago Press, Chicago and London, 1968. Paperback $3.85 (US). In this supplement to the third edition of this classic textbook Vertebrate Paleontology (1966), Romer discusses some areas of recent interest and some of the more controversial problems which would not be covered adequately therein.

Lichens and Air Pollution. A study of Cryptogamic Epiphytes and Environment in the Stockholm Region. Erik Skye. Acta Phytogeographica Suecica 52: 1-23, 110 figs plus maps and tables Uppsala, 1968.

Conservation of Vegatation in Africa south of the Sahara: Proceedings of a symposium held at the 6th Plenary Meeting of the "Association pour l'Etude Taxonomique de la Flore d'Afrique Tropicale." in Uppsala, Sept. 12-16, 1966. Inga and Olov Hedberg (Eds.). Acta Phytogeographica Suecica 54: 1-320. 1968.

Elements of Marine Ecology: An Introductory Course. R. V. Tait. Butterworths, Toronto and London, 1968 Illus, 280p. $14. (US).

Fish and Man, Conflict in the Atlantic Estuaries. John Clark. Special Publication Number 5, American Littoral Society, Highlands, N. J. 07752, 1967. Illus 78p. $1 (US).

Weather and Life: An Introduction to Biometeorology. William P. Lowry. Academic Press, New York and London, 1969. Illus. 305p.

Flashing Wings: the Drama of Bird Flight. John K. Terres. Doubleday, Garden City, N.Y., 1968, 177p. $4.95 (US).

The Biology of Marine Mammals, edited by Harold Andersen. Academic Press, New York and London, 508 pp. 1969. $21.50 (US). An advanced treatise on physiology and behaviour, especially those adaptive features fitting these animals for life in the water.

Handbook of the Birds of India and Pakistan Together With Those of Nepal, Sikkim, Bhutan, and Ceylon, Volume I: Divers to Hawks by Salim Ali and S. Dillon Ripky Oxford Univ. Press, New York. $12.75 (US).
This is the first of 10 volumes that will describe some 1200 species of kinds that can now be seen on the Indo-Pakistan subcontinent.

An Introduction of Tree-Ring Dating by Marvin A. Stokes and Terah L. Smiley. Univ. of Chicago Press. $5.85 (US).

Permafrost Investigations in Northern Ontario and Northeastern Manitoba by R. J. E. Brown, Technical Paper No. 291, Division of Building Research, National Research Council, Ottawa 46pp. Illus. 1968 $0.75.

Dictionary of Economic Plants by J. C. Th. Uphof. Second edition, enlarged and revised. J. Cramer, Lehre, Germany, 591pp. 1968. Under scientific names gives common name, plant family, kind of plant (e.g. tree, shrub ect.) geographic range, uses and chemical constituents if known; cross references from common names to scientific names. A wealth of information

Taxonomic Literature: A Selective Guide to Botanical Publications with Dates, Commentaries and Types, by Frans A. Stafleu. Regnum Vegetabile 52: 1-556. 1967. Published by International Bureau for Plant Taxonomy and Nomenclature, Utrecht, Netherlands.

The Breeding Biology of Ross' Goose in the Perry River Region, Northwest Territories, by John Pemberton Ryder. Dept. of Indian Affairs and Northern Development, Canadian Wildlife Service Report Series, No. 3, 56pp., Illus., 1967. Paper $0.75 from Queen's Printer, Ottawa.

Behaviour and the Regulation of Numbers in the Blue Grouse by J. F. Bendell and P. W. Elliott. Dept. of Indian Affairs and Northern Development, Canadian Wildlife Service Report Series No. 4, 76pp., Illus., 1967. Paper $1.00 from Queen's Printer, Ottawa.

Denning Habits of the Polar Bear (Ursus maritimus Phipps) by C. Richard Harington. Dept of Indian Affairs and Northern Development, Canadian Wildlife Service Report Series, No. 5, 30pp., Illus., 1968. Paper $0.50 from Queen's Printer, Ottawa.

Histoire Naturelle du Gode, Alca torda L., dans le Golfe Saint-Laurent, Province de Québec, Canada by Jean Bédard D.I.A.N.D., CWS Report Series, No. 7, 79pp., Illus., 1969. Paper, $1.25 from Queen's Printer, Ottawa. (This excellent study of the razorbill will be issued in English in a year or two).

Degradation of Herbicides P. C. Kearney and D. D. Kaufman, (Eds.) Dekker, N.Y., 1969 394p. (DM 79, 13).

Insect Photoperiodism St. D. Beck (Ed.), Academic Press, N.Y., London 1968, Illus. 288p. $12.50 (US)

The Biology of Euglena D. E. Buetow (Ed.) Vol. 1. General Biology and Ultrastructure. Academic Press, N. Y., London, 361p. $19 (US).

Darwin and the Beagle. Allan Moorehead. Thomas Nelson, 1969. Illus. 280p. $15 (US).

Rhythmic Phenomena in Plants. Beatrice M. Sweeney, Academic Press, New York, 1969. 148p. For the student who wants a clear explanation of the nature and fuction of biological rhythms. $7 (US).

Enumération des Plantes du Canada B. Boivin, 404pp. First serialized in Le Naturaliste Canadien, vols. 93-94, 1966-67; reprinted as vol. 6 of Provancheria, a series of Memoirs published by the Louis-Marie-Herbarium of the Faculté d'Agriculture, Université Laval, Quebec. With explanatory texts in French, repeated in English. Enumerates 5712 taxa (4139 species) for Canada, including special lists for adjacent territories of Greenland, Alaska and Saint-Pierre & Miquelon. Distribution by provinces and territories for each taxon. A bibliography of monographs precedes most families and genera, about 2150 entries. Some subtractions, especially for British Columbia. Last previous enumeration; Macoun's Catalogue of 1883-90 listed 3209 species for Canada.

Pollution, what it is, what it does, what can be done about it. W. J. Maunder (Ed.). University of Victoria, Victoria, B.C., 1969. 115p.

The Environmental Revolution; a guide for the new Masters of the Earth. Max Nicholson. Hodder and Stoughton, St. Paul's House, Warrick Lane, London, E. C. 4. 1970. 84s. (to be reviewed in a future issue of this journal).

Check List of the Vascular Plants of the Whiteshell Area in Manitoba. Janet R. Dugle. Whiteshell Nuclear Research Establishment, Atomic Energy of Canada Limited, Pinawa, Manitoba 1969. Mimeographed; slightly annotated. 57 pages.

Air Pollution Primer. Rena Corman. National Tuberculosis and Respiratory Disease Association, New York, 1969. Illus. 104p. Paperback.

Directory of Natural History, Conservation and Environment Organizations in Canada[1]

Annuaire des groupes s'occupant d'histoire naturelle, de conservation ou du milieu vivant au Canada[1]

THEODORE MOSQUIN[2] and M. T. MYRES[3]

National Organizations

The Alpine Club of Canada,
c/o Mr. Pat Boswell,
Box 1026,
Banff, Alberta.
Membership: 800
Publications: CANADIAN ALPINE JOURNAL (annual)
GAZETTE (quarterly)

Canadian Amphibian and Reptile Conservation Society,
Sec., Mr. J. Lovisek,
689 Gladstone Ave.,
Toronto 4, Ontario.
Membership: 85
Publications: C.A.R.E.S. BULLETIN (bimonthly)

Canadian Audubon Society,
46 St. Clair Ave. East,
Toronto 290, Ontario.
Membership: 2,200
Publications: CANADIAN AUDUBON (bimonthly)
(30 affiliated organizations)

Canadian Forestry Association,
Association Forestière Canadienne,
185 Somerset St. West,
Ottawa 4, Canada.
Publications: CFA NEWS — LE COURRIER.

Canadian Institute for Pollution Control,
Exec. Dir. May Groves,
Box 66,
Don Mills, Ontario.

Canadian Society of Wildlife and Fishery Biologists,
Société Canadienne des Biologistes de la Faune
Box 2292,
Station "D", Ottawa, Canada
Membership: 275
Publications: NEWSLETTER (quarterly)
OCCASIONAL PAPERS

Canadian Speleological Society,
Box 402,
Victoria, B.C.

Canadian Wildlife Federation,
La Federation Canadienne de la Faune,
Exec. Dir.: Mr. R. C. Passmore,
1419 Carling Avenue,
Ottawa 3, Canada.
A federation of all Canadian Sportsmens', Hunters' and Wildlife Societies.
Affiliated Membership: 175,000
Publications: WILDLIFE NEWS (NOUVELLES DE LA FAUNE) (quarterly)

Canadian Wolf Defenders,
President: Mr. T. C. Guest,
10989 - 126 St.,
Edmonton 40, Alberta.
Membership: 170
Publications: NEWSLETTER

Community Planning Association of Canada,
L'Association Canadienne d'Urbanisme,
425 Gloucester St.,
Ottawa, Canada.
Membership: 6,500
Publications: COMMUNITY PLANNING REVIEW (quarterly)

Ducks Unlimited (Canada),
1495 Pembina Highway,
Winnipeg 19, Manitoba.

National and Provincial Parks Association of Canada,
Exec. Dir. Mr. Gavin Henderson,
43 Victoria St., Suite 18,
Toronto 1, Ontario.
Membership: 1,400
Publications: PARK NEWS (quarterly)

The Nature Conservancy of Canada,
Exec. Dir.: Mr. F. Aird Lewis,
1407 Yonge Street,
Toronto 7, Ontario.
No formal membership.

[1]Reprints of this directory can be obtained from the Business Manager at $1.00 each.
[2]Editor, Canadian Field-Naturalist, Box 3264, Postal Station "C", Ottawa, Canada.
[3]Department of Biology, University of Calgary, Calgary, Alta.

Alberta

Alberta Fish and Game Association,
Sec. Mgr., Mr. Paul Morck,
8631 - 109 St., Room 212,
Edmonton, Alberta.
Affiliated Membership: 23,000
Publications: DEFENDING ALL OUTDOORS (monthly)

Alberta Forestry Association,
c/o Prairie Provinces Forestry Association,
4 - 809 Corydon Ave.,
Winnipeg 9, Manitoba.

Alberta Land Preservation Society,
Chairman: J. William Kerr,
Box 1132,
Calgary, Alberta.

Alberta Natural History Society (of Red Deer),
President: Mrs. E. M. Scoular,
4145 - 40th Street,
Red Deer, Alberta.

Alberta Wilderness Association,
Box 6398,
Station D,
Calgary 2, Alberta.

Alberta Wilderness Association
Lethbridge Chapter,
President: Byron Rutt,
Coaldale, Alberta

The Alpine Club of Canada (Calgary Section),
Box 1265,
Calgary, Alberta.
Publications: THE CHINOOK (monthly)

The Alpine Club of Canada (Edmonton Section),
c/o Miss Barbara J. Campbell,
12216 - 42nd Ave.,
Edmonton 73, Alberta.

Bow Valley Naturalists
President: Mr. G. D. Wilkie,
Box 347,
Banff, Alberta.
Membership: 56.

Calgary Field Naturalists' Society,
P.O. Box 981,
Calgary 2, Alberta.
Membership: 160,
Publications: CALGARY FIELD-NATURALIST (monthly)

Cold Lake Bird Club,
Sec., P. P. Desfesses,
CFB Cold Lake,
Box 1377,
Medley, Alberta.

Community Planning Association of Canada,
Alberta Division,
212 Barry Building,
10128 - 103rd Street,
Edmonton, Alberta.

Edmonton Bird Club,
Miss M. J. Wade,
6519-94th Street,
Edmonton, Alberta.

Edmonton Natural History Club,
P.O. Box 308,
14 Belmont Crescent,
Broxton Park,
Spruce Grove, Alberta.

Federation of Alberta Naturalists,
Box 981,
Calgary 2, Alberta.

Lethbridge Natural History Society,
President: Mrs. Frances Schultz,
1054 Henderson Lake Blvd.,
Lethbridge, Alberta.

National and Provincial Parks Association of Canada
(Edmonton Chapter)
President: Mr. K. Lazenby,
10845 - 86 Avenue,
Edmonton, Alberta.

National and Provincial Parks Association of Canada
(Calgary - Banff Chapter),
Box 608,
Sub Post Office 91,
University of Calgary,
Calgary, Alberta.
Publications: NEWSLETTER

Pollution Control Southern Alberta
Box 472,
Lethbridge, Alberta.

British Columbia

The Alpine Club of Canada (Vancouver Section),
P.O. Box 2377,
Vancouver 8, B.C.
Publications: AVALANCHE ECHOES (monthly)

The Alpine Club of Canada (Victoria Section),
Sec., Mrs. W. E. M. Mitchell,
2172 Granite Street,
Victoria, B.C.

Amalgamated Conservation Society,
Box 741,
Victoria, B.C.
Membership: Representing 14 organizations including angling, hunting, diving and several other groups.

B.C. Mountaineering Club,
Box 2674,
Vancouver 3, B.C.
Membership: 273,
Publications: THE B.C. MOUNTAINEER (monthly)

B.C. Waterfowl Society,
Box 2582,
Vancouver 3, B.C.
Membership: 542,
Publications: NEWSLETTER (quarterly)

British Columbia Wildlife Federation,
Exec. Dir., Mr. Geoffrey Warden,
3020 Summer Avenue,
Burnaby 2, B.C.
Affiliated Membership: 12,000
Publications: NEWSLETTER (monthly)

Canadian Forestry Association of British Columbia,
1201 Melville St.,
Vancouver 5, B.C.

Canoe Touring Club,
Mr. C. Dumfries,
7409 - 17th Ave.,
Burnaby 3, B.C.

Central Okanagan Naturalists' Club,
Mr. Earl W. Van Blaricom,
1260 Kelglen Cres.,
Kelowna, B.C.

Community Planning Association of Canada,
B.C. Division,
Room 201,
525 Seymour Street,
Vancouver 2, B.C.

Comox Mountaineering Club,
c/o Mr. J. Shark, Past Pres.,
R.R. 2,
Courtenay, B.C.

Comox-Strathcona Natural History Society,
Sec., Mr. W. J. Fitzpatrick,
Denman Island,
Pres., Mr. Keith Morton,
Box 1780,
Courtenay, B.C.

CONCERN
Consider Northern Communities' Environment and Resources Now,
Box 56,
Hudson's Hope, B.C.

Cowichan Valley Natural History Society,
Sec., Mrs. V. Bunny,
2844 Philip St.,
Duncan, B.C.

Enqual,
Environmental Quality,
Box 1086,
Victoria, B.C.
Publications: ENQUAL BULLETIN (quarterly)

Federation of British Columbia Naturalists,
P.O. Box 4246, Station D,
Vancouver 9, B.C.

Membership: Direct or through member clubs
Publications: NEWSLETTER (quarterly)
(mailing list, 2,000)

Island Mountain Ramblers,
c/o Mr. J. A. Cowlin,
3951 Margot Place,
Victoria, B.C.

Kamloops Outdoor Club,
Mr. George Eldridge,
Pres., H. M. Neave,
929 Douglas St.,
634 Tunstall Cres.,
Kamloops, B.C.

Kootenay Mountaineering Club,
Box 191,
Rossland, B.C.

Laymen's International Federation for Ecology,
P.O. Box 8600, Station "M",
Vancouver, B.C.

Mountain Access Committee,
Sec. Treas., Miss Mary Wells,
204 - 1540 W. 13th Ave.,
Vancouver 9, B.C.

Nechako Valley Wildlife Conservation Association,
Box 1077
Vanderhoof, B.C.

Nelson Natural History Society,
Mrs. Alan Burbank,
904 Silica St.,
Nelson, B.C.

North Okanagan Naturalists' Club,
Sec., Miss Kay Bartholomew,
Box 473,
Vernon, B.C.

North Shore Hikers,
490 W. St. James,
North Vancouver, B.C.

Northwest Wilderness Society of the Unitarian Church
949 W. 49th St.,
Vancouver 14, B.C.

The Okanagan-Similkameen Parks Society,
Box 787,
Summerland, B.C.
Membership: 1,000
Publications: NEWSLETTER (3 to 4 times yearly)

Outdoor Club of Victoria,
Sec., Miss L. I. Le Grys,
239 St. Andrews St.,
Victoria, B.C.

Outdoors Unlittered,
Box 203,
Victoria, B.C.

Pacific Salmon Society,
President: Mr. Lloyd Stewart,
Box 654, Postal Station "A",
Vancouver, B.C.
Membership: 300.

Prince George Naturalist Club,
Sec., Mrs. Margaret Vanderberg,
R.R. 1, Sintich Road,
Prince George, B.C.
Membership: 75
Publications: NEWSLETTER (monthly)

Richmond Antipollution Society,
Richmond, B.C.

Save Our Parkland Association,
1416 - 750 West Broadway,
Vancouver 9,
Sec., Mrs. N. R. McElroy,
808 W. 66th Ave.,
Vancouver 15, B.C.

Save The Beaches Association,
P.O. Box 525, Station A,
Vancouver 2, B.C.

Sierra Club of British Columbia,
c/o Terry Simmons, Chairman,
Geography Department,
Simon Fraser University,
Burnaby 2, B.C.
Membership: 100
Publications: NORTHWEST CONIFER (quarterly)

South Okanagan Naturalists' Club,
Sec., Miss Enid Maynard,
Lakeshore Drive,
Summerland, B.C.
Pres. Mr. Doug, Noel,
West Bench,
Penticton, B.C.
Membership: 78

SPEC
Society for Pollution and Environmental Control,
Head Office,
Room 2,
4857 Kingsway,
Burnaby, B.C.
Membership: 10,000

Campbell River,
Mr. Herb Power,
Telephone: 287-3049,
Campbell River, B.C.

Comox Valley
Mrs. Melda Buchanan,
Telephone: 339-3015,
Courtenay, B.C.

Duncan,
Mr. Kurt Horn,
Telephone: 746-4722,
Duncan, B.C.

Kamloops,
Mrs. Joan Negrin,
92 Seymour St.,
Kamloops, B.C.

Kelowna,
Mrs. Mary Irwin,
R.R. 4,
Kelowna, B.C.

Nanaimo,
Mrs. Bill Pemberton,
Telephone 753-8350,
Nanaimo, B.C.

North Vancouver,
Mr. Tom Taylor,
Apt. 24,
777 West Queens,
North Vancouver, B.C.

Surrey,
Mr. Don Startin,
Telephone 596-3198,
Surrey, B.C.

Victoria,
Mr. Menno Tromp,
2140 Oak Bay Ave.,
Oak Bay, B.C.

West Vancouver,
Mr. Hamish McIntyre,
5650 Eagle Harbour,
West Vancouver, B.C.

Thetis Park Nature Sanctuary Assoc.,
Sec., Miss M. C. Melburn,
2397 Heron St.,
Victoria, B.C.
Membership: 615.

University of Victoria Outdoors Club,
Student Union Bldg.,
University of Victoria,
Victoria, B.C.

Vancouver Natural History Society,
Box 3021,
Vancouver 3, B.C.
Membership: 750
Publications: BULLETIN (quarterly)

Varsity Outdoor Club,
University of British Columbia,
Vancouver, B.C.

Victoria Canoe Club,
Box 4191, Station "A",
Victoria, B.C.
Membership: 60
Publications: NEWSLETTER (monthly)

Victoria Natural History Society,
c/o Provincial Museum,
Victoria, B.C.
Membership: 460,
Publications: VICTORIA NATURALIST (9 issues a year)

West Kootenay Pollution Control Association,
President, Mr. Fred Stroes,
528-8th Ave.,
Castlegar, B.C.

Manitoba

The Alpine Club of Canada (Winnipeg Section),
Sec., Mrs. R. P. Sliney,
(Address not known)

Brandon Natural History Society,
(Address not known)

Community Planning Association of Canada,
Manitoba Division,
Group 4, Box 1,
R.R. 1,
St. Norbert, Manitoba.

Manitoba Forestry Association,
c/o Prairie Provinces Forestry Association,
4 - 809 Corydon Ave.,
Winnipeg 9, Manitoba.

Manitoba Scientists to Control Pollution,
Mr. Ben Berck,
Agricultural Research Station,
Winnipeg, Manitoba.
Publications: NEWSLETTER

Manitoba Wildlife Federation,
Exec. Dir. Mr. Paul Murphy,
1770 Notre Dame Ave.,
Winnipeg, Manitoba.
Affiliated Membership: 13,000
Publications: WILDLIFE CRUSADER (10 issues/yr.)

The Natural History Society of Manitoba,
c/o The Manitoba Museum of Man and Nature,
147 James Ave.,
Winnipeg 2, Manitoba.
Membership: 300
Publications: NEWSLETTER

National and Provincial Parks Association of Canada (Manitoba Chapter)
Mr. Hamish Gavin,
Box 981,
Winnipeg, Manitoba.

Pollution Probe,
Mr. David Krindle,
Room 216, Buller Building,
University of Manitoba,
Winnipeg, Manitoba.

Soil Conservation Society of America (Manitoba Chapter),
Winnipeg, Manitoba.

Wildlife Foundation of Manitoba,
Chairman: Mr. Allan Scarth, Q.C.,
208 Osborne St., North,
Winnipeg 1, Manitoba.

Zoological Society of Manitoba,
Clandeboye, Manitoba.
Publications: ZOOLOG (quarterly)

Newfoundland

Community Planning Association of Canada,
Newfoundland Division,
Court House,
Duckworth St.,
St. John's, Nfld.

Newfoundland Labrador Wildlife Federation,
Sec., Mr. Leslie Wilmott,
Milltown,
Baie d'Espoir, Nfld.
Affiliated Membership: 950.

The Newfoundland Natural History Society,
P.O. Box 1013,

St. John's, Nfld.
Membership: 150.

New Brunswick

Canadian Forestry Association of New Brunswick, Inc.,
Box 518,
Fredericton, N.B.

Conservation Council of New Brunswick,
President, Mr. K. K. Langmaid,
Agricultural Research Station,
Fredericton, N.B.

Fredericton Field Naturalists' Club,
5 Shamrock Terrace,
Fredericton, N.B.

Junior Audubon Clubs,
Supervisor: Mr. J. Otis Green,
Grand Manan High School,
Grand Harbour, N.B.

Moncton Naturalists' Club,
Mr. R. E. Hunter,
84 Fleet St.,
Moncton, N.B.

Nature and History Museum,
Grand Manan Island,
N.B.

Nature Study Group,
Sec., Mrs. Marilyn Cary,
Woodward's Cove, N.B.

New Brunswick Division,
Community Planning Association of Canada,
P.O. Box 501,
Saint John, N.B.

New Brunswick Wildlife Federation,
Sec. Treas.: Mr. Ralph Goodwin,
Box Site 14, Minto, N.B.
Affiliated Membership: 2,500
Publications: BULLETIN

St. John Naturalists' Club,
1157 Managoush Rd.,
Lancaster, N.B.

Sunbury Shore Art and Nature Centre, Inc.,
P.O. Box 100,
St. Andrews, N.B.

Nova Scotia

Community Planning Association of Canada,
Nova Scotia Division,
P.O. Box 211,
Halifax, N.S.

ECO
Mrs. Allison Parsons,
P.O. Box 3211,
Halifax South Postal Station,
Halifax, N.S.

Environmental Council of Nova Scotia,
President, Gilbert Hutton,
5410 Spring Garden Rd.,
Halifax, N.S.

Heritage Trust,
Pres., Allan Duffus,
Nova Scotia Museum,
Halifax, N.S.

The Linnaean Society of Nova Scotia,
Albert Lee,
Nova Scotia Museum,
Halifax, N.S.
Membership: 15
Publication: LINNAEA (annual)

Nova Scotia Bird Society,
c/o Nova Scotia Museum,
5410 Spring Garden Road,
Halifax, N.S.,
Membership: 500

Nova Scotia Forestry Association,
6070 Quinpool Ave.,
Halifax, N.S.

Nova Scotia Resources Council,
Dr. Donald Dodds, Chairman,
Biology Dept.,
Acadia University, Wolfville, N.S.

Nova Scotia Wildlife Federation,
Sec., H. D. Fairn,
Box 459,
Wolfville, N.S.
Affiliated Membership: 4,000

Ontario

Algonquin Wildlands League,
Box 114, Station "Q",
Toronto 290, Ontario.
Membership: 1,400
Publication: WILDLAND NEWS (monthly)

The Alpine Club of Canada (Ottawa Section),
Sec., Miss Helen Forsey,
No. 4, 105 Rosemont Ave.,
Ottawa 3, Canada.

The Alpine Club of Canada (Toronto Section),
Sec., Mrs. Judith Cook,
c/o 7 Relmar Gardens,
Toronto 10, Ontario.

Brantford Nature Club,
Sec., Mrs. Mac Makarchuk,
19 Lynnwood Drive,
No. 609, Brantford, Ontario.

Brereton Field Naturalists,
Sec., Mrs. E. Smith,
R.R. 2, Utopia, Ontario.

The Brodie Club,
c/o Dept. of Birds,
Royal Ontario Museum,
100 Queen's Park,
Toronto 5, Ontario.

The Bruce Trail Association,
(corresponding address)
33 Hardale Crescent,
Hamilton 56, Ontario.

Beaver Valley Bruce Trail Club,
Box 1327,
Meaford, Ontario.

Blue Mountains Bruce Trail Club,
Box 306,
Barrie, Ontario.

Caledon Hills Bruce Trail Club,
Box 302,
Waterloo, Ontario.

Dufferin Hi-land Bruce Trail Club
Box 354,
Shelburne, Ontario.

Iroquois Bruce Trail Club,
Box 183,
Hamilton, Ontario.

Lions Head Bruce Trail Club,
Sec., D. J. Caudle,
Lions Head, Ontario.

Lower Bruce Bruce Trail Club,
Box 491,
Wiarton, Ontario.

Niagara Bruce Trail Club,
Box 1,
St. Catharines, Ontario.
Membership: 100
Publications: NEWSLETTER (monthly)

Peninsula Bruce Trail Club,
Sec., Mrs. J. P. Johnston,
Tobermory, Ontario.

Sydenham Bruce Trail Club,
Box 431
Owen Sound, Ontario.

Toronto Bruce Trail Club,
75 Felbrigg Ave.,
Toronto 12, Ontario.

Community Planning Association of Canada,
Ontario Division,
32 Isabella Street,
Toronto 5, Ontario.

Committee of a Thousand,
Box 185,
Niagara Falls, Ontario.

Conservation Council of Ontario,
Board of Trade Building,
11 Adelaide St., West, Suite 604,
Toronto 1, Ontario.
24 Member Organizations
Publications: THE BULLETIN (quarterly)

Cornwall Amateur Herpetologists' Society,
c/o Mr. Gerald Swift,
216 Nelson St.,
Cornwall, Ontario.
Membership: 35

Federation of Ontario Naturalists,
Exec. Dir. Mr. Gerald McKeating,
1262 Don Mills Road, Suite 49,
Don Mills, Ontario.
Membership: 7,200 adults; 22,000 young naturalists
Publications: THE ONTARIO NATURALIST (quarterly)
THE YOUNG NATURALIST (monthly)
FON NEWSLETTER (bimonthly)

The Ganaraska Trail Association,
Mr. J. W. L. Goering,
57 King Street,
Port Hope, Ontario.

GASP
Group Action to Stop Pollution,
85 Richmond St. West,
Toronto 110, Ontario.
Membership: 450.

Georgetown and District Naturalists' Club,
Sec., Mrs. Cecil Davidson,
10 Albert St.,
Georgetown, Ontario.
Membership: 42,
Publications: BULLETIN (monthly)

Grey-Bruce Naturalists' Club,
Mrs. J. M. Thomson,
595-6th St., East,
Owen Sound, Ontario.

Guelph Field Naturalists' Club,
Mrs. Leslie Lougheed,
109 Lemon St.,
Guelph, Ontario.

Hamilton Naturalists' Club,
Sec., Mr. W. A. Gilmour,
49 St. James Place,
Hamilton, Ontario.

Huntsville Nature Club,
Mrs. Phil Bailey,
Box 103,
Huntsville, Ontario.

Ingersoll Nature Club,
Sec., Mrs. W. G. Garland,
143 Canterbury St.,
Ingersoll, Ontario.

Kent Nature Club,
President, Mrs. H. Tompkins,
20 Buckingham Ave.,
Chatham, Ontario.

Kingston Field Naturalists,
Box 831, Kingston, Ontario.
Membership: 150,
Publication: THE BLUE BILL

Kirkland Lake Nature Club,
Sec., Mrs. G. T. Honer,
15 Lakeshore Road,
Kirkland Lake, Ontario.

Kitchener-Waterloo Field Naturalists,
Mr. Norman Freedman,
259 Louisa St.,
Kitchener, Ontario.

Lambton Field Naturalists,
Pres., Mr. Roy John,
1062 Lockhart Circle,
Sarnia, Ontario.

Limberlost Nature Club,
Sec., Mrs. G. Hill,
Limberlost Lodge, Muskoka,
Via Huntsville, Ontario.

Littoral Society of Toronto,
Sec., Mrs. G. Flint,
Box 1094 Adelaide P.O.,
Toronto, Ontario.

Margaret Nice Ornithological Club,
Mrs. Janet Goodwin,
22 Lytton Blvd.,
Toronto 12, Ontario.

McIlwraith Field Naturalists,
Sec., Miss Margaret Ross,
834 Dufferin Ave.,
London, Ontario.

Midland-Penetang Naturalist Club,
Sec., Miss A. A. Dietrich,
R.R. 2,
Penetang, Ontario.

Napanee Nature Club,
Sec., Mrs. Manley Kimmett,
R.R. 7,
Napanee, Ontario.

Niagara Campers Association,
Sec., Mr. Don Haigh,
26 Sunnylea Drive,
St. Catharines, Ontario.

Niagara Falls Nature Club,
Mr. H. Martin,
336 Leader Lane,
Niagara Falls, Ontario.
Membership: 250
Publications: THE NIAGARA FALLS NATURE CLUB BULLETIN (monthly)

Nipissing Field Naturalists,
Donald Simpson,
966 Ann St.,
North Bay, Ontario.

Norfolk Field Naturalists' Club,
Sec., Miss Ellen Crafts,
33 Lynnwood Ave.,
Simcoe, Ontario

Ontario Bird Banding Association,
Sec., Miss A. Wasserfall,
22 Roycrest Ave.,
Willowdale, Ontario.

Ontario Camping Association,
Mr. Ivan Robinson,
501 Yonge Street, Suite 13,
Toronto 5, Ontario.

Ontario Campers and Hikers Association,
Mr. & Mrs. D. Bull,
75 St. Michaels,
Chatham, Ontario.

Ontario Federation of Anglers and Hunters,
Sec. Mgr., Mr. Ted Yates,
Suite 204, Lowrie Bldg.,
15 Yonge St. N.,
Richmond Hill, Ontario.
Affiliated Membership: 11,000
Publications: ONTARIO FISH AND WILDLIFE CONSERVATION (quarterly)

Ontario Forestry Association,
229 College St.,
Toronto 2B, Ontario.

Ontario Herpetological Society,
Mr. B. McBride,
9 Finchgate Court,
Willowdale 432, Ontario.
Membership: 50

Ontario Waterfowl Research Foundation,
Manager: Mr. W. Carrick,
387 Kortright Rd.,
Guelph, Ontario.

The Oshawa Naturalists' Club,
Box 354,
Oshawa, Ontario.

Oshawa Outdoor Club,
Canadian Union Office,
1148 King St. East,
Oshawa, Ontario.

Ottawa Field-Naturalists' Club,
Box 3264, Postal Station C,
Ottawa 3, Canada.
Membership: 1,300
Publications: CANADIAN FIELD-NATURALIST (quarterly)
TRAIL AND LANDSCAPE (5 times per year)

The Outdoor Club,
Civil Service Recreation Association,
c/o R.A. Centre,
2451 Riverside Drive,
Ottawa 8, Canada
Membership: 40.

Oxford Field Study Centre,
808 Dundas St.,
Woodstock, Ontario.

Penninsula Field Naturalists,
President, Mr. Frank Kingdon,
53 Wakil Drive,
St. Catherines, Ontario.

Peterborough Nature Club,
Mrs. T. Cumming,
829 Rishor Cres.,
Peterborough, Ontario.

Pollution Probe
Pollution Probe,
Carleton University,
Ottawa, Canada.
Membership 250
Publications: NEWSLETTER (monthly)

Pollution Probe,
University of Ottawa,
Ottawa, Canada.

Pollution Probe,
University of Toronto,
Toronto 181, Ontario.
Membership: 1,300
Publications: NEWSLETTER (monthly)

Pollution Probe,
Trent University,
Peterborough, Ontario.

Pollution Probe,
University of Waterloo,
Waterloo, Ontario.
Membership: 350.

Pollution Probe,
University of Western Ontario,
London, Ontario.
Membership: 200

Pollution Probe,
University of Windsor,
Windsor, Ontario.

Quetico Foundation,
Suite 305,
200 Bay Street,
Toronto 1, Ontario.

Quinte Field Naturalists,
Mr. Terry Sprague,
R.R. 1,
Demorestville, Ontario.
Membership: 70
Publications: THE QUINTE NATURALIST (monthly Sept-April)

Richmond Hill Naturalists,
The President,
c/o Richmond Hill Public Library,
Wright St.
Richmond Hill, Ontario.

Rouge Valley Conservation Association,
Pres. Mr. R. B. Atkins,
182 Brooksbank Dr.,
Don Mills, Ontario.

St. Thomas Field Naturalists,
Sec., Mrs. D. Mallott,
19 Elysian St.,
St. Thomas, Ontario

Sault Naturalists Club,
Sec. Treas., Mrs. Robert T. Baker,
306½ Armory Place,
Sault Ste. Marie, Ontario.

The South Peel Naturalists Club,
Box 91,
Port Credit, Ontario.
Publications: THE SOUTH PEEL NATURALIST

Stratford Field Naturalists' Club,
Mrs. D. McKerlie,
77 Woods St.,
Stratford, Ontario.
Membership: 40

Sudbury and District Committee on Pollution,
92 Frood Road,
Sudbury, Ontario.

Sun Parlour Nature Club,
Mrs. B. Runstedler,
40 Elm St.,
Kingsville, Ontario.

Thunder Bay Field Naturalists' Club,
Mrs. T. Perrons,
2113 Begin St.,
Thunder Bay, Ontario.

Toronto Field Naturalists' Club,
Sec., Mrs. M. Robson,
49 Craighurst Ave.,
Toronto 12, Ontario.
Membership: 900,
Publications: NEWSLETTER (monthly)
ONTARIO FIELD BIOLOGIST (annually)

Toronto Junior Field Naturalists,
Mr. Robert J. MacLellan,
416 St. Clements Avenue,
Toronto 12, Ontario,
Membership: 350,
Publications: FLIGHT (annually)

Toronto Ornithological Club,
Sec., Mr. E. Nasmith,
2056 Breezy Brae Dr.,
Port Credit, Ontario.

Underwater Club of Canada,
Box 26,
Adelaide Post Office,
Toronto, Ontario.

Victoria County Nature Club,
Sec., Mr. W. Jamieson,
50 Adelaide St. S.,
Lindsay, Ontario.

The Voyageurs,
Sec., Mr. M. Graziano,
109 Sonmore Dr.,
Agincourt, Ontario.

West Elgin Nature Club,
Sec., Miss P. Craig,
West Lorne, Ontario.

Willow Beach Field Naturalists,
Miss Hope Campin,
89 Hope St. North,
Port Hope, Ontario.

Woodstock Naturalists' Society,
Mr. Albert H. Cole,
278 Ingersoll Ave.,
Woodstock, Ontario.
Membership: 45,
Publications: BULLETIN (monthly)

Prince Edward Island

Prince Edward Island Conservation Assoc.,
President: Ian G. MacQuarrie,
Department of Biology,
University of P.E.I.
Charlottetown, P.E.I.
Membership: 25

Prince Edward Island Fish and Game Association,
Sec., Mr. Jack McAndrew,
22 West St.,
Charlottetown, P.E.I.

Prince Edward Island Natural History Society,
Andre Lavois,
28 Bayside Drive,
Southport, P.E.I.
Membership: 40.

Québec

The Alpine Club of Canada (Montreal Section)
Sec., Mr. Peter Gibb,
2665 Joseph Casavant Place,
Montreal 356, P.Q.
Publications: NEWSLETTER (monthly)

Arctic Institute of Canada,
Mr. Ken de la Barre,
3458 Redpath St.,
Montreal 109, P.Q.

Association des Camps du Québec Inc.,
952, rue Cherrier,
Montréal 132, Québec.

L'Association Canadienne d'Urbanisme
Community Planning Association of Canada,
Quebec Division,
Edifice Branly, Chambre 332,
1995 Boul. Charest E.,
Ste-Foy, Québec 10, P.Q.

Association Forestière Québecoise Inc.,
915, rue St-Cyrille Ouest,
Québec, P.Q.

Association des Jeunes Spéléologues québecois
a/s M. André Gamache,
C.P. 336 — Station Delorimier,
Montréal 178, Québec.

Barbara Richardson Wildlife Foundation,
18 Hillside Ave.,
Ste. Agathe de Monts, P.Q.

Le Cercle des Mycologues Amateurs,
a/s Père Bernard Taché,
Collège Sainte-Marie,
1180, rue Bleury,
Montréal 111, Québec.

Les Cercles des Jeunes Naturalistes,
Jardin Botanique de Montréal,
4101 est, rue Sherbrooke,
Montréal 406, Québec.
Publications: "LE NATURALISTE"

Le Cercle des Mycologues de Québec,
Dr. René Pomerleau,
Laboratoire de recherches forestières,
C.P. 35,
Sillery, Québec 6.

Le Club des Ornithologues de Québec, Inc.,
8191 Avenue du Zoo,
Orsainville 7, Québec.

La Fédération Québecoise de la Faune,
Quebec Wildlife Federation,
Sec., Paul E. Pageau,
6424, rue St-Denis,
Montreal, Québec.

Interprovincial Conservation Club,
Jacques Bouvier,
C.I.P. Nature Centre,
Harrington, P.Q.
Membership: 50

Les Jeunes Biologistes,
Collège Bourget,
Rigaud, Québec.

The Massawipi Bird Club,
c/o Dr. J. K. Lowther,
Bishops University,
Lennoxville, Quebec.

Montreal Mycological Club,
President: Dr. Jean R. Beaudry,
University of Montreal,
75 Holyrood St.,
Outremont, P.Q.

The Morgan Arboretum Association,
Macdonald College,
Ste. Anne de Bellevue, P.Q.

Ottawa Falconry Association,
Sec., Mr. H. Sharp,
Kirks Ferry, P.Q.

The Province of Quebec Society for the Protection of Birds, Inc.,
Sec., Mrs. G. I. Wightman,
40 King's Road,
Valois, Quebec.
Membership: 700
Publications: NEWS BULLETIN (monthly)

La Société de Biologie de Montréal,
a/s Monsieur Roch Carbonneau,
Départment des Sciences Biologiques,
Case Postale 6128,
Université de Montréal,
Montréal, Québec.

La Société d'Histoire Naturelle de la Pocatière,
La Pocatière, P.Q.

La Société Linnéenne de Québec,
a/s Michel Bureau,
Ecole des Sciences,
Université Laval,
Québec.

STOP
Society to Overcome Pollution,
Mrs. H. Cartwright,
14 Cedar Ave.,
Pt. Claire, P.Q.

La Société Provencher d'Histoire naturelle du Canada,
a/s M. Georges A. Leclerc,
628, rue Fraser,
Québec.
Membership: 400

Société Zoologique de la Maurice,
a/s Gerard L. Bellavance, D.C.
863 Rue St-Pierre,
Trois-Rivières, P.Q.

Le Société Zoologique de Québec, Inc.,
Jardin Zoologique de Québec,
Orsainville, Québec 7, P.Q.
Publication: LES CARNETS DE ZOOLOGIE

St-Francis Valley Field-Naturalists' Club,
Box 459,
Lennoxville, Québec.
Membership: 120

The Voyageurs Hiking Club,
Lachine Y.M.C.A.,
3955 Provost,
Lachine, P.Q.

X-Pollution,
Mr. R. Blaker,
CJAD,
1407 Mountain Street,
Montreal, P.Q.

The Zoological Society of Montreal,
Box 80,
Victoria Station,
Montreal, Québec.

Saskatchewan

Community Planning Association of Canada,
Saskatchewan Division,
2817 Wascana St.,
Regina, Sask.

Environmental Action Crisis Committee,
Mr. Jan Jesburger,
Dept. of Biology,
University of Saskatchewan,
Saskatoon, Sask.

Maple Creek Natural History Society,
President: Miss Keitha Francis,
Maple Creek Hospital,
Maple Creek, Sask.

Moose Jaw Natural History Society,
Mr. Murdoch Nelson,
1061 Hopkins Cres., Moose Jaw, Sask.
Membership: 90

Prince Albert Natural History Society,
Dr. G. B. Howard,
47-21st Street East,
Prince Albert, Sask.

Regina Natural History Society,
Box 1321,
Regina, Sask.
Membership: 181

Saskatchewan Forestry Association,
c/o Prairie Provinces Forestry Association,
4-809 Corydon Ave.,
Winnipeg 9, Man.

Saskatchewan Natural History Society,
Box 1121,
Regina, Sask.
Membership: 2,100
Publications: THE BLUE JAY (quarterly)
NEWSLETTER (quarterly)

Saskatchewan Wildlife Federation,
Sec. Mgr., Mr. Morris Ferrie,
1122 Temperance St.,
Saskatoon, Sask.
Affiliated Membership: 17,000

Saskatoon Natural History Society,
Jim A. Wedgwood,
610 Leslie Ave.,
Saskatoon, Sask.
Membership: 175

South Saskatchewan Wildlife Association,
Box 164,
Moose Jaw, Sask.

Swift Current Museum and Natural History Society,
Dr. Jan Looman,
491-2nd Ave. S.E.,
Swift Current, Sask.

Yorkton Natural History Association
President, Mr. Bill Gibson,
Yorkton, Sask.

Yukon

Yukon Conservation Society,
President, Mr. John Lammers,
P.O. Box 1063,
Whitehorse, Yukon.
Publications: NEWSLETTER

Note: Many individuals from across Canada kindly provided information for this directory; the authors gratefully acknowledge their assistance. A revision is planned for 1972. Additions and changes should be sent to The Editor, Canadian Field-Naturalist, Box 3264, Postal Station "C", Ottawa 3, Canada.

Report of Council to the Ninety-First Annual Meeting of The Ottawa Field-Naturalists' Club, December 8, 1969

During the past year, eleven meetings of the Council were held at the National Museum of Canada and the National Library: December 16, 1968, January 24, February 12, March 25, April 30, June 25, August 12, September 17, October 22, November 13 and November 27, 1969. The Club's business was conducted in the usual orderly manner.

Appointments for 1969 were made as follows:

Editor, The Canadian Field-Naturalist
— T. Mosquin

Business Manager, The Canadian Field-Naturalist
— W. J. Cody

Chairman, Publications Committee
— J. M. Gillett

Editor, Trail & Landscape
— Anne Hanes

Chairman, Public Relations Committee
— W. A. Holland

Chairman, Bird Census Committee
— F. M. Brigham

Chairman, Macoun Field Club Committee
— I. M. Brodo

Chairman, Excursions and Lectures Committee
— L. C. Sherk (succeeded by T. J. Cole)

Chairman, Natural Areas Committee
— R. Y. Edwards

Chairman, Finance Committee
— Luella Howden

Chairman, F.O.N. Affairs Committee
— H. N. MacKenzie

Chairman, Education Committee
— T. J. Cole

Chairman, Membership Committee
— Patricia Narraway

Report of the Publications Committee

Since the last report of Council, four numbers of The Canadian Field-Naturalist have been published. These include Volume 82, Number 4, October-December 1968, containing 104 pages, Volume 83, Number 1, January-March 1969, containing 88 pages; Number 2, April-June, containing 100 pages and Number 3, July-September, containing 107 pages. The breakdown of items by subject for the four numbers is as follows:

	Articles	Notes	Reviews
Botany	8	6	7
Herpetology	0	4	0
Ichthyology	2	2	2
Mammalogy	7	6	1
Ornithology	10	13	4
Miscellaneous	6	2	11

In addition to the above items there were three guest editorials and one written by our own editor, seven letters to the editor, ten items of news and comment and nineteen pages of other new titles following the review section.

Again the publication of The Canadian Field-Naturalist was supported by a grant of $500 from the Conservative Committee of the Canadian National Sportsmen's Show. This assistance is gratefully acknowledged.

Expenditures for The Canadian Field-Naturalist and Trail & Landscape are recorded in the financial statement of the Club.

Report of the Editorial Committee for Trail & Landscape

During 1969, Volume 3 of Trail & Landscape was published and mailed to about 550 local members of the OFNC and subscribers. It comprised 5 numbers, totalling 156 pages. About 50 articles appeared, of a popular non-technical nature. Subjects included Plants (11 items), Birds (12), Mammals (1), Amphibians, Reptiles (2), Invertebrates (4), the Landscape, including "Explorer's Corners" (7), Conserva-

ion and Club affairs (13), as well as Editorials, announcements, letters, photographs, book notices, etc.

Since its beginning in 1967, an important function of the magazine has been to give members a list of the forthcoming events of the Club, as provided by the Excursions and Lectures Committee. In the past year, an increased amount of information has been offered to members concerning actions taken on their behalf, and areas of involvement under consideration, by The Council of the OFNC.

Report of the Public Relations Committee

Continuing as the previous year we thank John Bird of the Ottawa Journal for inclusion of so many references to our Club activities in his column, also we appreciate the special feature article written by Betty Baird for the Journal Saturday section edition.

Also special thanks to Wilfred Bell of the Ottawa Citizen for his reporting of our Club activities in his column.

Reports indicate that the car decal and membership identification cards were well received by members.

Various ideas are being pursued for the advancement of our association.

Report of the Bird Census Committee

Several projects and activities were originated and completed this year.

(a) On May 18, 1969, the first group organized "May-roundup" was conducted within the thirty-mile radius. Within a twenty-four hour period, fifteen observers tabulated 168 species of birds which is a new high for the most birds ever recorded in the Ottawa area in one day.

(b) The task of updating and revising the local check list was undertaken. But in view of the fact some 2500 check lists still remain unsold, the project was deferred to 1969-70.

(c) The preparation of a book, "The Birds of Ottawa", was commenced in January 1969. To date, lists have been made of local specimens from Carleton University, including St. Pat's College and from the Fred Bourguignon collection. It is hoped that the book will be completed by 1971.

(d) Notes on the seasonal status of birds were summarized by committee members in Trail & Landscape. It is hoped that these articles will continue in the local magazine under the auspices of future committee chairmen.

(e) With regard to the Annual Christmas Bird Census certain changes have been made. In the Audubon Field Notes the name "Ottawa-Hull" will be used instead of "Ottawa" to emphasize the birds seen in Quebec. In addition, since more than 80 people will participate in the 1969-70 count, the areas within the circles have been subdivided from the 13 to 18 sections.

Report of the Macoun Field Club Committee

1. *Membership* — As usual, the Junior Group (grades 4-6) is over-subscribed (35 members +), and has a waiting list of about 6 or 7 at this time. The Intermediate Group (grades 7 and 8) has only 25 members, although this smaller group seems to be more viable and participatory than it has been in previous years. The Senior Group (grades 9-13) is extremely active and has a record-breaking membership of 31. (We ended last season in June with a membership of 13!) The cause of the boom in high school membership is very difficult to assess.

2. *Activities* — In the spring, field trips were taken by the Juniors and Intermediates to South March (for spring birds) and to Pakenham (Mary Stuart's farm) for the annual all-day field excursion. The Seniors had a three-day camping trip to Miss Stuart's farm in May, after

having explored the property on snow shoes in late January.

This season, the entire club did some mineral collecting in a quarry near Buckingham, Quebec. The Seniors took a trip to a black spruce bog near Ramsay Lake in the Gatineau, and have been visiting the Macoun Nature Study Area near Bells Corners almost every Sunday.

A symposium on "Continental Drift" was held in April by the Seniors with papers being read by five members (during two meetings). It was so successful, another symposium, this time on "Environmental Pollution" is planned for January. Twelve papers will be given by members during four meetings.

3. *Library* — The library holdings were increased by more than 150 volumes thanks to generous gifts by Mr. Archie Newman, Mr. Ed Greenwood, and the Kiwanis Club of Rideau, as well as many others. So many new books were added that new shelves had to be built for the club library. The library now has more than 500 volumes, and circulation is lively.

4. *New Assistant* — Mr. Dave Watson, assistant minerologist at the National Museum of Natural Sciences is now helping with the meetings and between-meeting preparations, along with Michael Shchepanek.

5. *Scholarship Winner for the F.O.N. Red Bay Camp* — The winner of O.F.N.C. scholarship this year for a week stay at the Red Bay Camp was Gordon Hamre of the Senior Group. Gordon is particularly interested in fish, but reported that there were many fields other than just ichthyology to pursue at Red Bay. He said the week was very stimulating and enjoyable. Gordon is serving the Macoun Club this year as editor of the Little Bear.

6. *The Little Bear* — The Club journal, the Little Bear, had an excellent issue last June with an unprecedented 49 pages of news, stories, poems, drawings, and natural history articles, all by the members. (Last year's issue had 25 pages.)

7. *Budget* — The increased budget (from $150 to $200) enabled the Club to purchase a number of good books for the library, to set up and stock our aquarium, and, of course, to take a number of bus trips.

Report of the Excursions and Lectures Committee

During 1969 the Chairman of this committee Mr. Sherk, left the area to take up a post in Toronto and Mr. Cole took his place as chairman. In the course of the year there were (or will be) a total of 10 Lectures and Demonstrations and 42 field trips all of which, so far, have been well attended. The newly introduced May Evening Walks proved very popular, and even in the rain, there was a good turn out.

After implementing the recommendation in last year's report that all reservations must be paid for, the Annual Dinner was a success both socially and financially. A total of 150 persons (including the guest speaker) strained the facilities of the R.A. Centre and highly favourable reports were received of both the meal and the lecture.

Report of the Natural Areas Committee

The Chairmanship of the Natural Areas Committee was accepted a year ago on the understanding that the Chairman did not know the area, and therefore, would be glad to lead where others showed the way.

I have since detected some doubts in the Club's mind over what should be done here. There is some desire to acquire and save natural areas, but collectively it is not much more than a lukewarm interest, or so it seems.

This is quite predictable. Ottawa is located near to an abundance of wild and semiwild land, and there seem to be few unique bits of habitat that are in need of saving. Mer Bleue is still a live issue, but seems to involve expenditures beyond the Club's means, and probably beyond the means of governments in these times of reduced programs and expenditures.

One major asset of the Ottawa-Hull region is Gatineau Park. If this Region never had another parcel of preserved wild land, this one large holding could make Ottawa a city quite unique in the western world. We have it now, yet it seems about to be planned away into an industrial and institutional area with elbow room, becoming no longer a park for people. Misguided planning and political opportunism will always be a threat to Gatineau Park, until specific legislation spells out clearly what the park is for, and what can and cannot be done with it.

It is easy for small clubs to spread themselves too thin. After a year of analysing the Ottawa need of wild land, it is my suggestion that the main continuing interest in land on the part of this Club be directed at obtaining adequate protection for Gatineau Park, and that other land matters be dealt with, individually, by short term subcommittees, each containing the best abilities for the specific problem at hand.

Report of the Finance Committee

It was decided during the year that all reserve funds, with the exception of Bell Telephone shares should go into the new 8 per cent issue of Canada Savings Bonds. It was also decided that the $5,000, Series 22 Canada Savings Bonds purchased from current account should be converted to the new series. This resulted in purchase of $10,700 in the new series. The funds came from the following sources:

Reserve Accounts Series 22 Canada Savings Bonds —	$1,700.00
Current Account Series 22 Canada Savings Bonds —	5,000.00
Maturing H.E.P.C. Bonds —	3,500.00
Cash from reserve bank accounts (approximately) —	500.00

Report of the Federation of Ontario Naturalists Affairs Committee

1. *Meetings* — Six meetings of the Board of Directors were held in 1969 of which I was able to attend only one. This is a common problem faced by our Club as the distance to Toronto necessitates at least an overnight stay. One way the Club might obtain better representation would be to have any member of the Council who plans to be in Toronto check with the Chairman of this committee regarding possible attendance at a F.O.N. meeting.

2. *Achievements* — The F.O.N. presented a brief to the Great Lakes Users Conference regarding the extremely limited degree of public access to the shores of the Great Lakes. Figures were presented to show that only 9.5 per cent of the shoreline lies within provincial parks and that most of that is on Lake Superior. The brief urged that, regardless of cost, more access should be acquired now because the costs can only go higher in the future.

3. *Projects* — Plans are being advanced to present a brief to the provincial Committee on Tourism and Natural Resources requesting legislation to protect endangered plant species, especially wild-flowers.

Extensive educational programs are being considered including the preparation of a natural history package for teachers and the development of audio-visual aids.

4. *F.O.N. Camps and Trips* — The annual F.O.N. Camp at Red Bay was held from June 28 to July 5 and attended by 41 persons. The reduction to one week was considered a success and the camp attracted a larger group of young people than in past years.

Trips included Algonquin Park Winter Weekend (in February), the Bruce Botany Weekend (in June), the Moosonee Field Trip (in June), the Manitoba Field Trip to Churchill Delta and the prairie country (in July) and the Kapiskau River on James Bay (in August).

5. *New Executive Director* — The popular and energetic Administrative Director, Gerry McKeating was appointed Executive Director of the Federation in the summer. He succeeds Jim Woodford who has retired to pursue a writing career.

Report of the Education Committee

This, the newest of the Committees, has held two meetings during the last quarter of the year and although no concrete results have yet been obtained, several ideas have been raised which are being investigated and the results of our activities should soon become known. I would like to put in a plea for assistance from the membership at large. It is not fair to ask the same few people to serve on several committees, worse, it limits our source of ideas. I would ask anyone who feels that they could help to contact me.

The membership of the committee in 1969 was:

Chairman — Mr. T. J. Cole
Members — Mrs. B. Coleman
Miss J. Dunston
Mr. H. N. MacKenzie
Mr. R. H. McDonnell
Dr. D. A. Smith
Mrs. H. A. Thompson

Report of the Membership Committee

Total membership 1969 — 803 (± 5) — includes 84 family memberships (2 votes) and 507 local memberships. Total new members (or change of status from individual to family and former associates) 1969 — 175 — includes 34 family and 50 former associates. Cancellations totalled 52 (26 for non-payment). This makes a total increase of 123 or 15.31 per cent over 1968.

As in past years, letters of welcome were sent out to all new members with the name of the donor indicated on those that were gifts.

This year, membership "wallet" cards were printed** and mailed to all voting members as their fees were received. These cards seemed to be well accepted by those members polled, and hopefully, will be issued anew in 1970.

Because of the changes in the constitution, new brochures were produced** and distributed to all excursion leaders, most council members and several reliable public outlets. Most local membership applications are submitted via the "tear-off" portion of these brochures which does indicate at least partially, how we are reaching the majority of our members.

Two hundred out of four hundred prepared copies of T & L accompanied by covering letters and about five application forms have been mailed out to dentists' and doctors' offices picked at random throughout the city. The response via the application forms has been less than ten and *no* doctor or dentist (by comparison of mailing addresses versus new membership lists) has requested membership. Since the cost of mailing alone (excluding T & L reprints, envelopes, etc.) is $10.00 per month, I would suggest this form of expensive advertising be dropped after 1969.

Proposals for 1970:

(a) More immediate totals of voting membership.
(b) Printing and mailing of membership cards for 1970.
(c) In affiliation with the Education and the Publicity Committees, determine *and* effect a campaign for membership in the schools and universities especially locally.
(d) Include with the mailing of the membership cards a survey sheet to obtain more accurate information regarding the age, interests, etc. of the membership.

The Ottawa Field-Naturalists' Club Statement of Income and Expenses

for the Year Ended November 30th, 1969

Income				
Fees from Subscriptions			$3,898.00	
Fees from Memberships & Affiliations			3,914.00	
Sale of Back Numbers			2,757.44	
Sale of Geology Magazines		$110.98		
Cost of Purchase	$1,563.75			
Less Inventory of Geology Magazines	1,482.00	81.75	29.23	
Sale of Reprints			2,239.78	$12,838.45
Less Cost of Publications				
– Canadian Field Naturalist			$5,696.50	
– Trail and Landscape			698.55	
– Reprints			899.54	7,294.59
				$ 5,543.86
Less Expenses				
Advertising			$ 166.72	
Bank Charges & Interest			39.85	
Committee Expenses Bird Census		$ 18.20		
– Excursions & Lectures		69.90		
– Delegation Expenses		58.10		
– Macoun Field Club		156.76	302.96	
Honoraria			400.00	
Incidentals			344.89	
Postage			619.57	
Printing & Stationery			533.50	
Salaries			724.50	3,131.99
				$ 2,411.87
Other Income – Donations			$ 500.00	
– Interest & Dividends			749.64	
– Miscellaneous			88.74	
– U.S. Premiums			317.80	1,656.18
Surplus				$ 4,068.05

The Ottawa Field-Naturalists' Club Balance Sheet

as at November 30th, 1969

Assets

Current			
Cash in Bank and on Hand		$ 5,633.43	
Cash in Savings Account		95.36	
Bills Receivable		578.46	
Accrued Interest Income		66.70	
Inventory of Geology Magazines		1,482.00	$ 7,855.95
Fixed (at cost)			
Furniture, Fixtures & Equipment			723.91
Investments & Securities			
Bell Telephone Company of Canada — 35 shares (Market Value $1,305.00)		$ 1,617.20	
Canada Savings Bonds – due Nov. 1st, 1978		10,700.00	12,317.20
			$20,897.06

Liabilities & Equity of Surplus or Deficit

Current Liabilities			
Income Received in Advance		$ 1,716.52	
Accounts Payable		2,700.00	$ 4,416.52
Equity of Surplus or Deficit			
Balance, Dec. 1st, 1968		$12,147.34	
Add: Capital Gain on Sale of H.E.P.C. Bonds	$ 265.15		
Surplus for the year 1968-1969	4,068.05	4,333.20	
Balance, Nov. 30th, 1969			16,480.54
			$20,897.06

Note: Estimate inventory of magazines $25,000.00

(Signed) L. G. Howden (Auditor)
J. M. Gillett (Auditor)
F. M. Brigham (Treas.)

Instructions to Contributors

Manuscripts

Authors should submit two manuscripts (original and carbon copy), each complete with abstract, tables, and illustrations. Manuscripts should be typewritten on paper measuring 8½ x 11 inches. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Words meant to appear in italics should be underlined. Every sheet on the manuscript should be numbered.

Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text in all manuscripts except in letters to the editor. In no case should any words be abbreviated; this includes references to tables and figures as well as literature citations.

The tables should be titled and numbered consecutively in arabic numerals. Tables should be placed each on a separate page after the Literature Cited. Captions to figures should be typed together on one page. Authors are requested to use at least one given name.

The **Style Manual for Biological Journals** is recommended, in general, as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be as determined by the editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Coordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted without space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly 7½ × 5¾ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors are asked to share the cost of publication by paying $22.00 for each page in excess of six journal pages. The cost of illustrations and the setting of tables and of small-sized type are also normally charged to the author.

Reprints

Reprints, with or without covers may be purchased. The cost is given on the reprints order form which is attached to the galley proofs. Members in good standing can request a 10% reduction in reprint costs.

Affiliated Societies

Edmonton Bird Club

President, P. H. Thompson; *Honorary President,* R. Lister; *Past President,* J. C. Finlay; *Vice-President,* K. W. Smillie; *Treasurer,* R. Heath; *Field-Secretary,* R. W. Turner; *Audubon Representative,* P. Demulder; *Secretary,* Miss M. J. Wade, 6519 94 St., Edmonton, Alberta; *Librarian,* Mr. A. W. Rupp, 97 Westbrook Dr., Edmonton 76, Alberta.

Calgary Field-Naturalists' Society

Address: Box 981, Calgary 2, Alberta, *President,* Dr. John Powell; *Vice-President,* Peter Karston; *Secretary,* W. Garry McKay; *Treasurer,* Margaret Powell; *Directors,* Mrs. Hattie Boothman and Dr. M. T. Myres; *Editor,* The Calgary Field-Naturalist, John W. Price.

McIlwraith Field Naturalists' Club

President, Mr. Ted Maddeford; *Past President,* Dr. W. H. Minshall; *Vice-President,* Mrs. Spencer Inch; *Corresponding Secretary,* Miss Margaret Ross, Apt. 9, 179 Oxford Street East, London; *Treasurer,* Mrs. Walter Wake, 1354 Longmuir Ave.; *Chairman Audubon Films,* Mr. G. Fred Bates, 366 Burlington Crescent, London; *Chairman Conservation Council,* Mrs. P. W. Tracey, 261 Briscoe St., London; *Editor,* Cardinal—Dr. Frank Cook, 1 Larkspur Crescent, London, Ont.

Vancouver Natural History Society

President, Mrs. W. J. Smith; *First Vice-President,* Mr. A. W. Greenius; *Second Vice-President,* Mrs. J. M. Anderson; *Treasurer,* Mr. E. G. Barnes, Box 3021, Vancouver 3, B.C.; *Corresponding Secretary,* Mrs. H. Pinder-Moss; *Membership chairman,* Mrs. E. Barnes; *Editor,* VNHS Bulletin, Mrs. R. A. Pilkington.

Nova Scotia Bird Society

President, Dr. Eric Mills; *Vice-President,* Dr. B. K. Doane; *Past President,* Mr. Ian A. McLaren; *Editor,* Mrs. J. W. Dobson; *Membership Secretary,* Miss E. Crathorne; *Secretary-Treasurer,* Miss M. Claydon, c/o Nova Scotia Museum of Science, Spring Garden Road, Halifax, Nova Scotia.

Province of Quebec Society for the Protection of Birds

President, Mr. M. D. Spencer; *Vice-Presidents,* Mrs. E. S. Cooper, M. H. Ouellet; *Honorary Treasurer,* Miss G. E. Hibbard; *Honorary Secretary,* Mrs. G. H. Wightman, 40 King's Rd., Pointe Claire, P.Q.; *Librarian,* Mrs. E. Brosseau.

Toronto Field Naturalists' Club

President, Mr. John A. Gingrich, 225 Coldstream Ave., Toronto 12, Ontario; *Vice-President,* Mr. Clive Goodwin; *Secretary,* Mrs. H. Robson, 49 Craighurst Ave., Toronto 12, Ontario; *Treasurer,* Mrs. F. F. Mathers; *Editor,* Mr. Elmer Talvila; *Junior Club,* Mr. Robert MacLellan, 416 St. Clements Ave., Toronto 12, Ontario.

The Saskatchewan Natural History Society

Honorary President, Fred G. Bard; *President,* Gordon Silversides; *Past President,* W. A. Brownlee; *First Vice-President,* J. A. Wedgewood; *Treasurer,* George R. Dodd, 33 Malone Crescent, Regina, Sask.; *Corresponding Secretary,* Mrs. Leith Knight, 843 Elgin Avenue, Moose Jaw, Sask.; *Editor,* The Blue Jay, George F. Ledingham, 2335 Athol St., Regina, Sask.; *Assistant Editors,* Margaret Belcher and Robert W. Nero; *Editor of* Newsletter, James Slimmon, 2526 Hanover Ave., Saskatoon, Sask.

THE CANADIAN FIELD - NATURALIST

PUBLISHED BY

The Ottawa Field - Naturalists' Club

BOX 3264, POSTAL STATION 'C'
OTTAWA 3, CANADA

Second Class Mail Registration No. 0527
Return postage guaranteed

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Volume 84, No. 2 Ottawa April-June, 1970

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Club is a corporate member of the Federation of Ontario Naturalists.

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by the Ottawa Field-Naturalists' Club with the assistance of affiliated societies and of a contribution from the Canadian National Sportsmen's Show. All material intended for publication should be addressed to the editor. Opinions and views expressed in this journal are private and do not necessarily reflect those of the Ottawa Field-Naturalists' Club or any other agency.

Membership and Subscription

The annual membership fee of $5.00 for individuals covers subscription to the journal. Libraries and other institutions may subscribe at the rate of $10.00 per year (volume). Applications for membership, subscriptions, changes of address and undeliverable copies should be mailed to: Treasurer, Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa 3, Canada. Return postage guaranteed.
Second class mail registration number 0527.

Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919, are obtainable from the Business Manager.

Cover photo: Western escarpment of the Long Range Mountains, Newfoundland, part of the area proposed for National Park status. This spectacular part would be excluded from the Park by the plan proposed by the province. See article on the Newfoundland National Park Potential in this issue. Photograph Courtesy Dr. W. O. Pruitt, Jr.

I would like to become a member of THE OTTAWA FIELD-NATURALISTS' CLUB and to receive the quarterly journal THE CANADIAN FIELD-NATURALIST

Name (Dr., Mr., Mrs., Miss) ______________________________
(In block letters)

Address ______________________________

____

____

____
(Include postal zone)

I would like my membership to start with

January of this year ☐

January of next year ☐

My membership fee of $5.00 is enclosed.

____
(Signature)

(Mail to) Treasurer,
Ottawa Field-Naturalists' Club,
Box 3264 Postal Station 'C',
Ottawa 3, Canada.

Please note that all library and institutional subscriptions to THE CANADIAN FIELD-NATURALIST are $10.00 a year (volume)

The Canadian Field-Naturalist

VOLUME 84 APRIL - JUNE, 1970 NUMBER 2

TABLE OF CONTENTS

Mailing date of this issue, October 16, 1970
Mailing date of previous issue, June 30, 1970

Proposal for Aquatic Parks and Reserves in Canada

The sun-lit fronds of kelp gently undulating in the waves, the royal purple of a starfish, the blue and gold of a darting cunner, or the shimmering silver of a school of minnows are delights that skin and scuba divers have come to know in recent years in Canada's marine and inland waters. With mask, swimfins and snorkel, a new world of inner space can be discovered. As on land, there is a need for parks to be set aside for recreation, enjoyment and study. Such parks can exclude man's developments, motorized transport, debris, and pollution to preserve the native animals and plants, peace and beauty. Park services could provide information on underwater animal and plant life. Signs and even nature trails can be arranged underwater and camping facilities on adjacent land areas can be made available.

The rising number of divers would favour the creation of underwater parks in the near future. Estimates now place the number of scuba divers in Canada at about 5,000, with about five times that many skin divers. As many divers will attest, the underwater habitat is badly in need of protection. Too many persons regard bodies of water as convenient garbage dumps. Consequently, bottoms are commonly littered with cans, bottles, tires, etc. Protection of the habitat and of the organisms that live in it are two prime reasons for setting aside natural areas as parks.

Aquatic parks, like land parks, should probably be classified according to their function, recreation, or faunal and floral reserves. With a goal clearly in mind the park can be designed to suit its function. Most terrestrial parks now permit fishing within their boundaries, although hunting and flower picking are prohibited.

Thought might be given to reserving some lakes and streams with clear waters and interesting topography in present parks for underwater observers. But new freshwater and marine parks should probably be selected with a view towards representing the natural floral and faunal assemblages of Canadian waters.

Underwater parks already have been established in the U.S., Kenya, Israel and Australia. With a French-Canadian, Gagnon, co-inventor of the Aqualung, Canada should not be far behind these forward-looking nations.

D. E. McAllister

The Newfoundland National Park Potential

WILLIAM O. PRUITT, JR.
Department of Zoology,
University of Manitoba,
Winnipeg, Manitoba.

A problem of concern to all Canadians is the desperate need for more National Parks. The exploding human population and its increasing urbanization combine to require not only more parks but also parks accessible to the major population centres.

The philosophy of National Parks, their rationale for being, is that they act as living displays or museums of ecosystem types. Any area that has a well-developed example of one ecosystem is potentially a National Park. If one encounters or can delimit a single contiguous area that combines several ecosystems or features generally agreed as of National Park calibre, then that area is especially valuable.

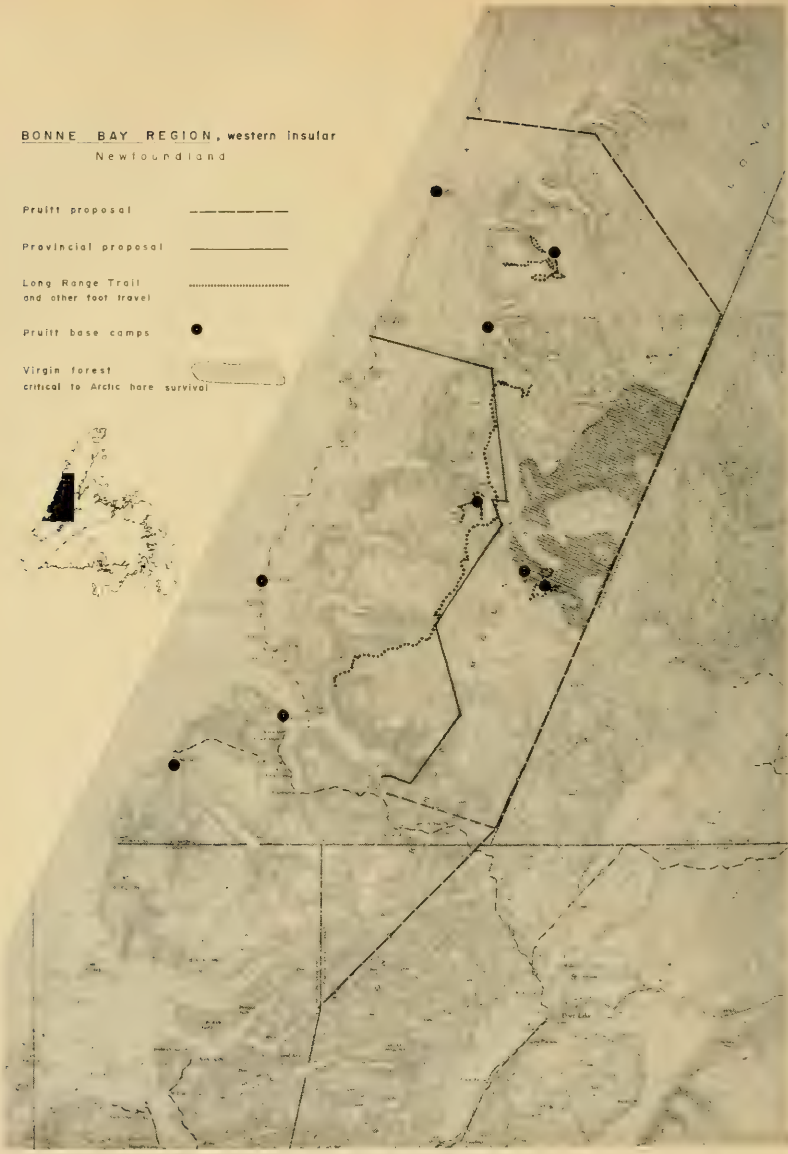
A National Park should be, as far as possible, an ecologically closed system, that is, it should be large enough and of such a shape as to be virtually independent of environmental changes that may go on outside its boundaries. Because of the interdependence of all living things on the surface of the earth complete ecological self-sufficiency is, of course, never possible, but is a goal toward which park planners strive.

There is another function of National Parks that, to me personally, is even more important; their role as scientific control areas. The essence of the scientific method is the controlled experiment wherein one manipulates a variable while concurrently observing the phenomenon under pristine conditions. The unvarying set is the control. It is easy to visualize a controlled experiment in a chemistry laboratory, for example. But the control must also exist in a field experiment in ecology. Whenever one changes the biota, by cutting, by hunting, by fishing, one engages in an experiment. The only way the forester or the wildlife manager can tell whether one technique is better than another technique is to compare the results with an unmanipulated or control area. I cannot overemphasize this point — without control areas the resource manager cannot discern whether his new cutting program, for example, or his new harvest regulations, are an improvement over the old or whether any changes observed are caused by long-term climatic shifts or maybe cyclic fluctuations in animal populations. I look upon this role as scientific control areas as the most important function of National Parks. (The fact that National Parks have been little used for such purposes in the past is not important; they will be used as such in the future).

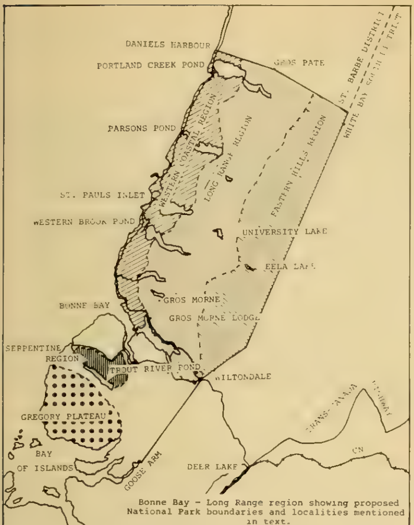
In the 400-year history of the occupation of the island of Newfoundland, one region has been mentioned time and again as being of National Park quality — Bonne Bay and the adjacent Long Range. Even before Confederation there were proposals to establish a National Park in the region. After Confederation of Newfoundland with Canada in 1949, the proposals have continued. Because, legally, the first move toward establishing a National Park must come from the Provincial government concerned, it was 1965 before this important step was taken. Since that time the proposal has alternately forged ahead and bogged down in a maze of counter-proposals and political machinations.

In spite of the proposals and the publicity the region is still *terra incognita* to the rest of Newfoundland and to Canada. In earlier days access to the region was only by boat in summer or dog-team in winter. Since the opening of the Northern Peninsula road in November, 1962, and the bypass around Bonne Bay in 1967 tourist travel has increased dramatically. Nonetheless, many people in Newfoundland still do not believe that my photographs of the staggeringly beautiful Bonne Bay, Gros Morne and the Long Range were taken in their home province!

My own interest in the region began even before I went to Newfoundland in 1965. Shortly thereafter I received a contract from the Canadian Wildlife Service to make a wildlife survey



Map of the Long Range Area.



Map of the Long Range Area showing regions referred to in the text.

of the region of the proposed park in an effort to anticipate any wildlife problems that might arise therein.

My contacts with the region, then, have been from base camps indicated on the map, a winter trip into the Eastern Hills region, low-level survey flights over all the region, and a 50-mile cross-country hike down the Long Range.

From these field studies I have evolved certain conclusions about the region, its suitability for becoming a National Park, and the boundaries necessary to ensure a high degree of ecological independence (a "closed system") of a Park.

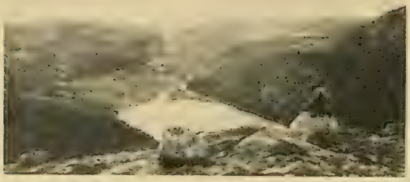
Ecologically there are three major and two minor regions in my park proposal (see map).

Western Coastal Region: This region extends from the shoreline to approximately the upper limit of tree growth on the western escarpment of the Long Range and has received exceptionally ruthless treatment by man and domestic stock for several hundred years. The climate, especially wind, appears severe. Consequently the forest vegetation is patchy, scrubby and dense. Wind-pruning is a prominent feature in two sections — 1) along the coast, especially between the road and the shore and 2) along the western escarpment between approximately 500 feet elevation and timberline which, on these exposures, is about 2000 feet.

A few words on the wind-pruned vegetation are in order. (I suspect snow-breakage is of equal importance in shaping "tuck".) In the local vernacular this "tuckamoor" or "tuck" lies as an almost impenetrable barrier to human travel. As one ascends the slopes, the deciduous trees disappear, leaving spruce and fir. These species, with increasing elevation, become shorter and more densely branched until at about 500 feet elevation they form a reticulum of intertwined branches. This three-dimensional maze continues until at about 1500 to 1700 feet elevation the height of the trees drops below the height of a man and becomes even more dense. Here one can sometimes walk or balance on top of the tuck until the usual alpine sedge-lichen-moss cover appears at about 2000 feet. There is rarely a sharply-defined timberline, nor are there typical sharply-defined clumps of krumholz or a forest-tundra belt.

Tuckamoor is of considerable importance to large mammals, including man, by impeding their movement. Wherever it occurs, not only

Head of Parson's Pond Inlet, June 28, 1966. Fogs and cloud formations are a frequent occurrence on the western slopes of the Long Range.



Long Range Mountains, west arm of University Lake.

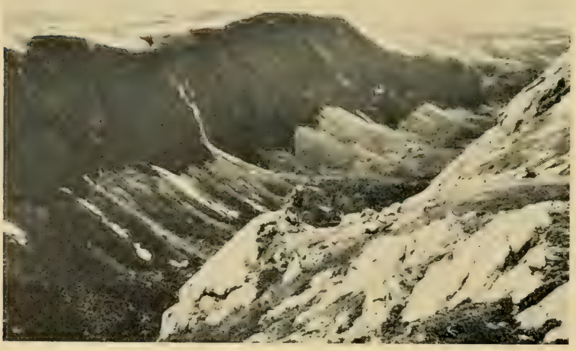
Perched glacial erratic boulders on top of mountain in the Long Range. The provincial proposal would exclude all land beyond the lake.

in the Western Coastal Region but as a zone around each of the domes and ridges of the Long Range and the Eastern Hills regions, the movements of moose, caribou and man are virtually restricted to well-defined game trails. The trails lead from each valley to the domes, across the intervening valleys or ravines but only rarely do they traverse the tuckamoor zone horizontally or along the contours.

Long Range Region: This region includes not only the alpine knobs, ridges and plateaus but the intervening valleys as well. Most of the western-facing slopes or exposures of the Long Range have the zone of tuckamoor already discussed. The eastern slopes are less dense, and the Eastern Hills region has eastern slopes that are relatively easy to traverse. Consequently in the latter region moose are not as restricted in their movements as they are in parts of the western region.

In the Long Range there are extensive alpine plateaus stretching for a number of miles. These plateaus, including the Gregory Plateau, have a snow cover atypical of alpine regions. It is very thick, dense and wind-beaten and over wide expanses it is complete with no vegetation or rocks protruding but with a surface of kaioglaq and other drift forms. The Gregory Plateau has a particularly heavy snowfall.

In the Long Range, particularly on the east-facing slopes, deep and extensive snow banks,

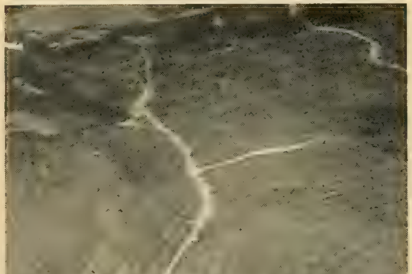


One of the fiords that dissect the western slope of the Long Range.

Scenery along the proposed Long Range Trail.

called zabois, that do not melt until some time the subsequent summer are perhaps the single most important ecological feature. Topographically-controlled, the zabois form in looping lines along the down-wind (snow-depositing) slopes. There are no trees in a zaboi site, neither is there tuck. The slope is usually of moss-covered rocks, with alder concentrated on the uphill rim and a sedge seepage mat along the lower. Among the rocks are forbs and bracken fern, plants that can survive with a short growing season. The forbs leaf out in altitudinal and exposure sequence, thus affording a long-lasting spring food supply for moose. Most of my moose observations have been of animals surprised feeding in zaboi scars. Some zabois support a thick sedge turf. The vegetational differences appear to be caused by different lengths of growing season as the zabois melt away. The presence of zabois must also influence normal weathering processes. In addition, moose traverse the zabois scars and push through the adjacent tuck to the next scar.

Eastern Hills Region: This region extends from the Long Range to well east of the St. Barbe-White Bay South boundary. It is a region of river valleys, many minor hills and several ridge-systems protruding into the alpine zone. Perhaps the most important feature of this region (and great areas of the preceding region, also) is the fact that it is virtually untouched by man. This is all the more astonishing when one remembers the virtually-complete destruction of natural conditions in the Western Coastal Region and the man-made desert, caused by clear cutting for pulpwood, which is expanding toward this region from the Bowater-controlled lands to the east. The area is already being actively invaded by professional guides' hunting and fishing lodges. In the valleys and up the



Long Range Mountains, clearcutting for pulpwood south of Lomond, June 15, 1967. This would be the fate of essentially all the forest in the region unless protected by park status.

Ferry Gulch, east side of Gros Morine in background, the vegetation here is very dense tuckamoor.

slopes is the most magnificent forest in Newfoundland — great spruces, firs and birches up to 3 feet d.b.h., all dripping with *Usnea* and *Alectoria*. The forest floor is littered with huge downed trunks, moss-covered and with ranks of small firs growing along them. The floor has *Cornus canadensis*, *Clintonia*, several small orchids and scattered small shrubs such as *Amelanchier*. It is quite open and affords easy walking. It is reminiscent, on a smaller scale, of course, of the rain forest of the Pacific Coast or of higher elevations in the Great Smokies. The critical virgin forest within my proposed boundaries constitute only about 28,800 acres. It is all on land that was originally given to Bowaters Pulp and Paper Company by an earlier, even more naive, provincial government. The 28,800 acres is about 0.3 percent of Bowaters total holdings (which incidentally encompass 30 percent of the Island of Newfoundland.)

Above the virgin forest lies a relatively narrow zone of tuck below the alpine zone. The domes are a series of rocky knobs with glacially-grooved bedrock and scattered erratic boulders. The vegetation is sedge, several ericaceous shrubs, mosses and lichens. In the low spots the spruce tuck grows up to streamline the landscape.

This region has an exceptionally heavy snowfall. In the vicinity of Eela Lake in mid-February 1967 at only a few places in the woods could I touch the ground with a handle of a 140-cm ski-pole. In most places the snow cover was much thicker than this. I estimated the *average* forest snow cover to be about 5 to 10 feet thick.

Gregory Plateau: Southwest of Bonne Bay the Gregory Plateau rises steeply from the Gulf. It is basically similar to the Long Range in most respects but being closer to the sea has a greater snow fall. The slopes of the Gregory Plateau and the region around the head of Trout River Pond support a virgin birch-spruce-fir forest. This forest is swiftly disappearing through lumbering.

Winter campsite at Eela Lake. Uncut virgin spruce-fir-birch forest.

Upland bog with Eela Lake in the background.

Virgin spruce-fir-birch forest at Eela Lake with alpine "dome" in the distance.

Serpentine Region: South of the road between Bonne Bay and Trout River lies an almost-barren reddish-brown rocky plateau. The region is an almost-continuous outcrop of Serpentine. Few species of plants grow here; the aspect is desert-like. An inordinate percentage of the species of plants found in the Serpentine Region are endemic or disjunct outriders from their main range. Several deep valleys, holding extensive zabois until late in the summer, run icy-cold streams that plunge down the sides of the plateau in cataracts and falls.

The Mammals

In order to appreciate the mammals of the Bonne Bay region one must remember that in many respects Newfoundland has a fauna that resembles an oceanic island rather than a continental-shelf island. It is a "waif fauna" composed of chance immigrants. Thus the mammalian fauna is unbalanced with more carnivorous species and fewer herbivorous species than one would expect. Moreover, Newfoundland, indeed the entire country east of Hudson Bay, seems for some unknown reason to support a lower mammalian biomass than does north-central or north-western North America. Consequently we are dealing with a mammalian fauna depauperate in species and low in biomass. Such terms as "common" or "rare" must be viewed in the Newfoundland context. For example, we are dealing with only about 600 caribou for all this large region.

The following mammals were formerly present, are known from the region now or from nearby regions and may be present.

MASKED SHREW (*Sorex cinereus*). The original stock of this mammal, introduced into Newfoundland in 1958, has increased and is spreading at the rate of some 17 miles per year. Shrews are now found in the Park region and well beyond it along the Northern Peninsula.

BATS. I have collected no bats in the region but *Myotis lucifugus* and *M. keenii* are known from the island. *Lasiurus cinereus* could be expected to occur also. All local residents queried about bats claimed they had noted a great decline in numbers "in recent years".

MAN (*Homo sapiens*). In primeval times the coastal region was inhabited by people with Dorset culture. The shore from Norris Point to Rocky Harbour contains a number of flint-chipping sites. Some historians believe that the early Norsemen might have put ashore at the mouths of some of the fjords.

BLACK BEAR (*Ursus americanus*). The distribution of this species is peculiar. Certain areas are known as good bear country and the species is very common around the logging operations to the east in the White Bay South district, but in other parts of the proposed park I could detect no evidence. The best area appears to be the Long Range region.

POLAR BEAR (*Thalarctos maritimus*). This is a rare accidental species. Individuals may come

ashore in late winter or early spring when the pack ice presses against the shore. None have ever been known to breed on the island. They are usually shot immediately upon arrival.

MARTEN (*Martes americana*). This excessively rare mammal seems on the verge of extinction in insular Newfoundland. The principal known present range on the island extends from the Annieopsquotch Mountains west to the head of St. George's Bay, then northeast on the east side of the Trans-Canada Highway to about Deer Lake, then north to the St. Barbe boundary and east to the head of White Bay. I have found no sign of this species within the proposed park region but there is a sight record from Silver Mountain, a few miles east of the St. Barbe boundary and in the Eastern Hills region. There are unconfirmed sight records by Provincial foresters from the base of the western escarpment.

Extensive areas of mature fir with scattered remnant white pine seem to be the preferred Newfoundland habitat for marten. Thus it may be possible to reintroduce marten into the Park. If such were decided, the virgin forest in the Eastern Hills region and along the Trout River ponds would be especially valuable.

SHORTTAIL WEASEL (*Mustela erminea*). I have several specimens from the Park region, donated by local trappers.

MINK (*Mustela vison*). Mink were introduced into insular Newfoundland primarily as escapes from fur farms. They have now spread over most of the island and are common in the Park region.

RIVER OTTER (*Lutra canadensis*). Otter are relatively common in the streams of the Long Range and Eastern Hills regions but not in the streams running into Bonne Bay. I suspect their scarcity there is due to trapping. There is virtually no otter habitat above the fall line on the western escarpment. Most of the streams flowing west plunge over the escarpment in high falls and their upper reaches are usually devoid of fish. The high alpine lakes are also markedly oligotrophic.

COLOURED FOX (*Vulpes fulva*). Coloured foxes are common throughout the region. Red is the usual colour phase.

WHITE FOX (*Alopex lagopus*). This species is accidental; a few individuals come ashore from sea ice when it touches the land in late winter and early spring. Most individuals are reported to come ashore in White Bay and then drift westward although some make land along the western shore. They survive in the Long Range or along the western shore for periods of months. None have been known to breed on the island.

WOLF (*Canis lupus*). Now extinct in insular Newfoundland.

LYNX (*Lynx canadensis*). In the general Park region lynx are relatively uncommon at present, since the snowshoe hares are low and also because good hare habitat is scarce. Both hares and lynx are more common at present between Bonne Bay and Deer Lake. Note the especial significance, discussed later, of lynx to Arctic hare.

BEAVER (*Castor canadensis*). Beaver are relatively common throughout the general Park region.

CHIPMUNK (*Tamias striatus*). This exotic species has been introduced in Squires Provincial Park about 20 miles east of the St. Barbe boundary. Their status there is unknown, but they seem to be surviving. If they spread from the Provincial Park they probably will quickly ecise the cutover region between their present locus and the Eastern Hills region. They are a potential food source for marten.

HOUSE MOUSE (*Mus musculus*), and NORWAY RAT (*Rattus norvegicus*) — Both of these introduced species are excessively common in the Western Coastal Region especially in the vicinity of villages or houses. In a relatively mild climate such as insular Newfoundland these exotic species can survive away from edificarian habitat. Thus they may be common in fields, near dumps, around and near caches of lobster pots or fishing sheds on the shore, in or near abandoned buildings or logging camps.

MEADOW VOLE (*Microtus pennsylvanicus*). This species is quite local and disjunct. It is found in almost all habitats. Only above the tuck zone, in areas of snowbed vegetation, have

Long Range Mountains. Beaver pond north of University Lake. Typical subalpine forest of the Long Range.

I noted signs of large populations. Here there may be accumulations of several quarts of scats.

MUSKRAT (*Ondatra zibethica*). Because of the terrain, good muskrat habitat is scarce in the proposed Park region, and this species is relatively rare.

SNOWSHOE HARE (*Lepus americanus*). This exotic species is now well established in Newfoundland. Numbers fluctuate in the classic cycle. At present they are low in the Western Coastal Region but seem to be on the upswing between Bonne Bay and Deer Lake. They are *relatively* common in the Western Coastal Region because of the disturbed habitat conditions but in the Long Range and Eastern Hills regions they are quite rare. In the clear-cut areas east of the St. Barbe boundary hares are again relatively common.

ARCTIC HARE (*Lepus arcticus*). This large hare is one of the most interesting mammals in Newfoundland. At one time it was widespread and relatively common in the "barrens" and alpine regions. It has become progressively more scarce until today it is one of the rare mammals of Newfoundland.

Arctic hare requirements seem to be: open, windswept areas with large rocks protruding from the ground in shapes that cause anmana or hollows to form in the moss, and in the snow. In winter the hares apparently take advantage of the expansion of their tundra habitat when the adjoining tuck becomes covered with snow; they then range to lower elevations to the edge of the forest. The hares are not creatures limited solely to alpine tundra, but are also associated to some extent with tuck and forest vegetation. In summer they avoid areas of tuck although they may rest adjacent to such areas. Old-timers in the region report having found, in the springtime, veritable "windrows" of hare scats along the edges of the tuck zones.

Several boreal ecologists have noted a relationship between moose and snowshoe hares

Long Range Mountains, Arctic Hare one mile west of Blackspoll Lake, June 13, 1967. Hare is changing from winter into summer pelage.

wherein moose, in winter, pull down and break small birches, willows and alders while feeding on the upper branches and thus bring a source of food within reach of the hares. A similar relationship exists between moose and Arctic hares. Such a food source, presented only in winter, could be the attraction that brings the Arctic hares to the fringe of the forest at that season.

An additional source of winter food for Arctic hares are the tops of alders (*Alnus* spp.) which are bent over by the heavy qali accumulation characteristic of the region. I emphasize these sources of winter food because the winter snowcover of the hares' summer habitat is remarkably complete as well as dense and hard. The moist maritime snow sticks to all it touches, so that even convex ground surfaces are snow-covered. Other races of Arctic hare occur in regions where the more continental-type winter snowcover is sparse and wind-blown. Thus *Lepus arcticus bangsi* resembles in this regard *L. othus* of the western Alaskan maritime tundra more than the arctic hares of the central Arctic tundra.

It should be abundantly clear that in spite of the name "Arctic" *Lepus arcticus bangsi* is directly associated with forest vegetation during at least part of its annual cycle.

The former Chief Biologist of the Newfoundland Wildlife Service, A. T. Bergerud, has advanced a quite plausible explanation of the observed fact that Arctic hares and snowshoe hares cannot exist together. There does not seem to be any direct competition but snowshoe hares indicate unsuitable biotic conditions.

In the days before the snowshoe hare was introduced to insular Newfoundland the local race of lynx (*Lynx canadensis subsolanus*) was a rare animal. Indeed, some authors have questioned if it was actually a member of the pre-contact fauna. After the snowshoe hare was introduced and "exploded" over the island, the lynx also increased. Arctic hares, having a lower reproductive potential than snowshoe hares, are more susceptible than the latter to population mortality factors. In pre-contact times the lynx was too rare to influence the Arctic hare population. After the lynx population increased, and after it gained an alternate source of food, the classic predator-prey link between it and the Arctic hare was broken. Thus lynx could now catch an occasional Arctic hare in the course of its other hunting. With snowshoe hares as a main food source, the Arctic hare population could be hunted to extirpation without the law of diminishing returns operating.

Thus Arctic hares require freedom from snowshoe hare populations as well as relative freedom from predation. It is highly significant that, in each instance studied, remnant Arctic hare populations are isolated from the snowshoe hare population.

An arctic hare population, in order to be secure, should be at least far enough away from a snowshoe hare population so that the accompanying lynx do not include the Arctic hare habitat in their home range. Saunders (1961) noted that Newfoundland lynx had home ranges with radii approximately 4.23 miles (extremes up to 8.0 miles). He also made the very important observation that lynx activity coincided almost exactly with areas of snowshoe hare activity. Snowshoe hares, in turn, rarely ventured into barrens or mature forests.

With these facts and ideas in mind, my records of Arctic hare in the proposed Park area fall into a reasonable pattern. Most reports come from the upland north of the East Arm of Bonne Bay and east of Gros Morne. This is an extensive area of upland, containing large stretches of alpine tundra with intervening strips of tuck or occasional forest. In each of these instances the habitat was not surrounded by areas of extensive tuck, but by broad reaches of mature forest (unused by snowshoe hares) which came quite far up the slopes.

The combination of all these requirements means that present Arctic hare range in Newfoundland is indeed restricted. Every precious bit must be cherished.

CARIBOU (*Rangifer tarandus*). Three, apparently separate, populations of caribou inhabit the proposed Park region:

1. Until about 1950 an isolated herd occurred in the Gregory Plateau region. In 1965,

Long Range Mountains. Newfoundland Caribou on winter range, plateau northeast of Parson's Pond.

15 animals were released south of Trout River village. I have observed winter tracks in several places between the Gregory Plateau and the upland west of Goose Arm Brook. This region is a partly-forested, rugged region with upland "barrens" interspersed with bogs, lakes and forest. Being on the downwind side of the Gregory Plateau it is probably in a snow shadow.

In 1968 caribou were seen on the upland northwest of Curzon village. These individuals undoubtedly are a part of the Gregory Plateau group.

2. The Long Range and Eastern Hills regions between Western Brook Pond, Silver Mountain and north to include the watershed of Main River is the summer range of a herd of about 150 caribou that winter in the Humber Valley between about Alder River and Sandy Lake and the Canadian National tracks. Their fawning grounds remain unknown.

This, the so-called "Humber Herd" is endangered because of the serious depletion of the winter range and because the winter range is bisected by the Trans-Canada Highway, a situation which favours poaching.

3. The Northern Peninsula herd winters in the extensive upland between the heads of Parsons Pond and Portland Creek Upper Pond. While the Humber Herd moves roughly north and south, the Northern Peninsula herd moves east for its summer range to the country along the eastern slopes of the Long Range, the Cat Arm River and its watershed. This herd numbers about 450 animals.

Their winter range is in a rather circumscribed area where they are highly vulnerable to poaching since they can be seen from the coastal settlements. The best winter range is an area of alpine tundra of only about 6 square miles at the western edge of the Long Range upland. Parts of it are indeed different from most other upland areas in the vicinity, being quite similar to *Eriophorum* tussock tundra winter range in northern Alaska. The Alaska range is called locally "spotted tundra" because the fierce winds of winter sweep the snow from the tops of the tussocks. The tops and sides of the tussocks support an amazingly rich flora of lichens and other sedges a well as heaths and dwarf birch. The Long Range area does not have tussocks but a microtopographic substitute. Rounded boulders (usually ¼ to 1 meter across) have become covered with moss, which give footing for sedges, lichens, dwarf birch, heaths and other plants. In the channels between the boulder-cored mounds or hummocks are mosses (mainly *Sphagnum*), sedges and other moisture-loving species. Drainage has worn channels so that the hummocks are aligned with the channels becoming furrows. I suspect that in winter the fierce winds from the Gulf roar up over the edge of the plateau and sweep the snow from the tops of the mounds, analogous to their action in the Alaskan situation.

If the Northern Peninsula herd of caribou were to increase there would be an excellent chance of the animals spreading westward from the upland onto the extensive bogland between the Long Range and the coast. In earlier days (perhaps until about 1850) caribou frequented Big Marsh, an extensive bog system north of Rocky Harbour in the Western Coastal Region. If the critical winter range were included within the Park they may survive and increase in numbers. Because of their accessibility for observation, animals that might repopulate this area would be an important feature of the Park.

Indeed, in about 1964, three caribou were seen on the highway near St. Paul's village.

MOOSE (*Alces alces*). The introduced moose have spread over most of insular Newfoundland. The best summer range is reported to be between Eela Lake and the head of Western Brook Pond. Moose are reported to move from the Long Range eastward to the Humber and Main River valleys in late fall and early winter. Bulls reinvade the Long Range upland earlier in spring than do the cows.

I have observed moose nearly everywhere I have been in the proposed Park region. Foot travel cross-country is virtually impossible without following moose trails. Throughout the tuck zones the moose trails are deeply churned into the soft, water-soaked peaty soil. A trail leading up or down hill may be eroded two or three feet below ground level. Considering that none of these trails are older than about three-quarters of a century, moose emerge as important agents of erosion in the region.

During my winter studies I have located numerous moose yards in the uncut region south and southeast of Eela Lake. In every instance the yard was on the east side of a dome or ridge that protruded above timberline. Immediately below the alpine zone was a belt of very heavy qali accumulation where the trees were completely white. Below this belt was another where the qali accumulation was still heavy but where the treetops were bare. Here were the yards. Number of moose per yard varied from 3 to 10.

Hunting for moose and caribou (as well as angling in the lower lakes and rivers draining eastward) are the stimuli that takes most people into the region of the proposed Park. About 20-30 moose per year are removed.

Discussion

It goes without saying that an area designated as a National Park should fulfill that purpose. One should not enter serious discussion with preconceived ideas about boundaries, number of acres concerned, or shape of area. The only consideration should be the final result — a National Park that fulfills the purpose it was designed for.

One of the recreational uses of the Upper Humber River.

Of extreme importance to the success of any National Park is its ecological independence, its establishment and continuation as a relatively closed ecosystem. Politicians, unfortunately, usually lack this concept and seem to be locked into a "total acreage" concept. One wonders at the high correlation between political ability and ecological ignorance.

The main purpose of a National Park in western Newfoundland, its "character", encompasses the Long Range and three species of mammals — the Newfoundland race of caribou, the Newfoundland race of marten and the Newfoundland race of the Arctic hare. These three endangered species of mammals in the proposed Park region have remarkably similar survival requirements as far as boundaries of a protected area are concerned.

It is clear that a Park of sufficient size to ensure total protection of all three caribou herds is politically unlikely. All three herds are of potentially great value as tourist attractions, apart from their scientific value. Large proportions of their critical range can be encompassed in a Park of reasonable size, but saving only part of the range needed for their annual cycle is futile. Therefore I have recommended to the Provincial Government that special Caribou Management Areas be established outside my proposed Park boundaries because caribou and *rational* forest use are not incompatible. The most important parts of the ranges of the Humber and Northern Peninsula

herds would thus be protected, while essentially all of the Gregory Plateau herd's range would be within the Park itself.

When one recalls the size of lynx home ranges, and the incompatibility of snowshoe hare habitat and mature forest, then one realizes that the approximate eastern boundary of the area necessary for survival of Arctic hare is near the St. Barbe - White Bay South boundary.

Since the prime requirement of marten habitat is mature forest the approximate eastern boundary of the Park must include as much of the forested valleys of the Eastern Hills Region as possible. I suggest the eastern boundary of the Park roughly follow the St. Barbe-White Bay South boundary, certainly no farther west.

The southern boundary should run from the head of Goose Arm to near Wiltondale in order to include the winter range of the Gregory caribou herd.

The northern boundary should run from Portland Creek or Daniels Harbour to Gros Pate and then east to the St. Barbe-White Bay South boundary in order to include the winter range of the Northern Peninsula caribou herd.

These boundaries are predicated on the establishment of two Caribou Management Areas, one for the winter and migration ranges of the Humber herd and one for the summer range of the Northern Peninsula herd. If such Caribou Management Areas are not established then the Park boundaries should be adjusted outwards to encompass the critical regions.

Of course, human habitation sites would undoubtedly be excluded from the Park by boundary manoeuvers ("enclaves"). Since these all occur in the Western Coastal Region along the shore and the road I anticipate no grave biological conflicts with Park aims.

The boundaries I propose for the Long Range National Park thus delimit one single area that combines:

1. Coastal scenery and associated traditional human activity such as fishing, lobstering and picturesque villages, the famous Bonne Bay itself with the surrounding hills and the coastal krumholz.

2. The western escarpment of the Long Range with the spectacular sheer cliffs of the fjords, and the tuck zone.

3. The Alpine zone of the Long Range, including the isolated massif of Gros Morne, the Serpentine area and the Gregory Plateau.

4. The virgin forest of the valleys of the Upper Humber and Main rivers, as well as the intervening alpine domes.

5. Sufficient habitat to ensure survival of populations of at least two of the three endangered species — the Newfoundland races of caribou and Arctic hare. We just don't know enough about the ecology of the Newfoundland marten to state definitely that such a protected area would positively ensure its survival. I personally think it would.

It is a rare occurrence, indeed, when so many worthy National Park objectives can be achieved in a single, relatively small area with uncomplicated boundaries. A park such as I propose would be of great biological significance not only for the survival of endangered species but as a scientific control area.

This size and shape of National Park would also offer a variety of high-quality visitor experiences. The present route for tourists into the region is by way of Cabot Strait and the Trans-Canada Highway to Deer Lake, thence by provincial road to Wiltondale. Here the route splits, one way going to the South Arm of Bonne Bay to Trout River or Woody Point, the other way going along the East Arm to Gros Morne Lodge and Rocky Harbour. Undoubtedly another important future access to the region will be from the north, by way of a road along the North Shore of the Gulf of St. Lawrence, a tunnel or high bridge crossing to the Strait of Belle Isle and thence south along the Northern Peninsula.

The prime tourist-attraction animal in the Park is without doubt the Newfoundland caribou. All three herds offer potential experiences for the visitor. If the Humber and Northern Peninsula herds were to increase, as they undoubtedly would when furnished with adequate protected range and when freed from poaching losses, they would reinvade their old haunts in the Western Coastal Region, where they are easily accessible to visitors.

Views of Arctic hare will probably always be reserved for the more active visitors, those prepared to hike inland and to climb to its habitat on the windswept alpine areas. Indeed, visitor utilization of the Arctic hares' fragile alpine habitat must be stringently controlled to prevent overuse.

There is one visitor attraction which has not received much official attention but which may turn out to be the most important. This is the sea bed itself. Bonne Bay is a fjord, relatively unpolluted and biologically rich. As part of my long-term plan for the Park I visualize a series of under-water tubes on the floor of the fjord with viewing ports strategically placed so that the visitor may walk dry-shod under Bonne Bay and watch lobsters and other sea creatures at close range.

The usual view of the Long Range from the coastal road is interesting enough, but even a short side trip up Western Brook or Bakers Brook fjord will reveal spectacular scenery. The Park I envision possesses the most magnificent scenery in North America east of the Medicine Bow Range in Wyoming. For example, the cliffs of Western Brook fjord fall sheer 1,500 to 2,000 feet. Someday these cliffs, and other rock-faces in the Park, will be world-famous among rock climbers and mountaineers.

In the summer 1969 Mr. John Folinsbee and I walked most of the length of the Long Range in the proposed Park. Our walking trip appears to have been the first of its kind through the region (although several people have crossed the Long Range and the Northern Peninsula on foot from west to east and vice-versa). We chose our route after detailed study of stereo-pairs of aerial photographs. Actual experiences on the ground caused us to modify frequently our actual route from the planned one. We inked our actual path on the photos. Thus there now exists a tested route along the alpine zone of the Long Range through most of the length of the proposed National Park. We walked mostly through the alpine regions, coming down from the high plateaus only to cross the intervening tuck-filled valleys and their rocky rivers. We skirted the heads of the glacially-gouged fjords and frequently walked for miles along zabois scars. Although some of the Long Range Trail is at present difficult passage through tuckamoor, it is, in general, uniquely easy travel because the alpine zone is here at a low elevation and intense glaciation has smoothed most of the rough edges from the route.

Eventually the trail could be cleared through the worst stretches of tuck, marked, and shelters built at suitable intervals, similar to the system along the Appalachian Trail. A hiking trail such as this, through spectacular scenery, with moose, caribou, black bears, and ptarmigan readily visible, would soon become a prime tourist attraction.

Gros Morne Lodge could stock equipment and dehydrated foods; parties could park their cars there and be transported to Parsons Pond and thence by boat to the head of Parsons Pond Inlet or Portland Creek Inner Pond. Here they could begin foot travel up the slopes to meet our surveyed trail. The portion of the trail up the slopes would need clearing and would require the most preparation. After hiking the Long Range Trail, a 7 or 8 day trip, the parties would end up at Gros Morne Lodge again. I predict such an experience would become one of the major attractions of the Long Range National Park.

The Long Range Trail would inspire eventual extension of the Appalachian Trail from Mt. Katahdin through the Maritimes, then into Newfoundland and into the Long Range (or possibly the Anguille Mountains) through the Long Range National Park and on to the tip of the Northern Peninsula. Since the Long Range is geographically a part of the Appalachians such a trail is logical. I can even visualize a time when the trail would be extended through Labrador along the coast, into a future Mealy Mountains National Park and then into the Torngat Mountains.

The Park I have described has been essentially the same as the Federal proposals. The Newfoundland government on the other hand, has offered a series of "parks" that are tiny misshaped bits of land which are biologically totally inadequate and which would be nightmares to administer. Since the provincial proposals seem to vary with each succeeding Minis-

ter of Mines, Agriculture and Natural Resources in the Provincial Government, the "provincial" boundaries on the accompanying map are only approximate.

All the provincial proposals carefully leave out of the Park the virgin forest required for survival of Arctic hare. Indeed, the provincial proposals eliminate essentially all the forested areas from the Park. Moreover, their division of the Park into two isolated units would pose innumerable administrative difficulties.

The most recent provincial proposal is for a park consisting of:—

(a) The Long Range alpine zone and

(b) the Serpentine area.

Thus the provincial proposals are not even notable for scenery, since the hills surrounding Bonne Bay itself would be available for pulp-cutting and would soon be sere and brown, criss-crossed with bulldozed roads and skid trails for the "timberjack" machines.

Mere scenery is not enough for a truly great National Park. It is necessary to ensure the maximum value by having a park with the greatest possible variety of tourist attractions. What the park experts call a "high quality park experience" includes not only scenery but solitude, independent living as well as wildlife observations.

Under the provincial proposals only small parts of the required annual range of caribou would be protected. Consequently these caribou would undoubtedly follow so many other groups of Newfoundland caribou into extirpation.

Under the provincial proposals the Arctic hare in the region would almost certainly be extirpated, since essentially none of the buffering forest in the region would be preserved.

We do not really know how the provincial proposals would affect marten, but we are fairly certain that there would be left no habitat suitable for reintroductions.

The provincial proposals, with their biological inadequacy, complicated boundaries, fragmented units and incomplete visitor potential are virtually textbook examples of how not to make a National Park.

During my winter work in the region I was impressed with the difference between the snowcover of the uncut forest in the Eastern Hills Region and the tundra-like landscape of the clearcut region to the east. On the barren cutover lands the snowcover is only a fraction of the thickness it is in the mature forest. Thus the retention of the virgin forests in the Eastern Hills region is also necessary to ensure stable water levels in the Humber and Main rivers.

There are a number of political ramifications which have been exposed by the present Park controversy. Perhaps the most astonishing thing is the realization that Newfoundland has no true National Park today. Terra Nova National Park, in spite of its name, is not a fully protected area since at the time of its establishment the province reserved the right to cut pulpwood in it if the province decided they required it! One of the saddest things I ever heard was the present Provincial Premier gleefully and proudly recounting in public (1 March 1969) how he had in effect prostituted the National Park Act. I predict that because of this action he will be remembered in the future histories of North America in the same category as Warren Harding and Albert Fall.

During the same public address the Premier also recounted how he had bamboozled the Federal Government by juggling the location of Terra Nova National Park and its boundaries so that the Federal Government was forced to construct a longer section of the Trans-Canada Highway through the revised park, thus saving the province a few million dollars.

I recount these examples to stress the situation that the Provincial government fails to understand the basic philosophy of National Parks. It is obsessed by old-fashioned ideas of "industry" and such faulty concepts as tax concessions to attract industry. It fails to recognize that Canada is in the post-industrial age, that we are in a new world where clean air, clean water, big trees and wildlife are in short supply and are the commodities in great demand. It fails to recognize the results of studies in the United States that show that the return on money invested in a National Park is 46:1. It fails to realize that a mine or industry that is given tax concessions actually costs the government more money than it gets back.

A large proportion of the people of the Bonne Bay region live, frankly, in poverty. Thus the Premier's public chant of "jobs, jobs, jobs, jobs" has a profound effect when contrasted against the more abstract appeal of long-term benefits.

Consequently the recent "discovery" of quartzite indications on the north shore of East Arm must be scrutinized critically. The announcement and subsequent events bear a strong resemblance to the old Yukon mining trick of "boiling a stampede". First there was the discovery of "colours", then this rumoured into a "find", then into the "most important discovery in eastern Canada" and finally blossomed into being mentioned in the Throne Speech in the Provincial Legislature! The Newfoundland people, after a long history of economic disappointments have become jaded to everything except spectacular announcements, yet because of this series of economic disappointments they hope desperately for an authentic miracle.

One should also be highly sceptical of the importance of any mineral discovery in Newfoundland. Mining is officially presented as the second most important industry in the province. I find this hard to believe since only 5,800 people are employed in mining, out of a total Newfoundland labour force of 136,000. The Newfoundland mining industry is officially valued at $320 milion dollars annually, but of this vast sum about all that stays in Newfoundland are the wages of 5,800 men. There is a profound difference between the value of the product extracted and the money which actually filters down to the people in the form of wages.

National Park dollars are especially important since they are "new money" brought into the region from outside. National Park dollars are also "free money", that is, it goes directly to the local people and cannot be controlled by any policy-intrigue between an exploiting company and a local government. National Park dollars are not obvious, there are no impressive factories, no great holes in the ground. But the money is there just the same, circulating from the visitor to camp ground operator, service station manager, restaurant owner, laundromat operator, etc.

Even if the "colours" discovered happened to have the potentiality of a full-fledged quartzite operation there is considerable doubt whether it should be allowed to do so, regardless of jobs promised. A quartzite "mine" is actually a quarry, a type of operation that would run silty waste into the Bonne Bay fjord. Not only would the fisheries be affected but the underwater potentialities of the proposed Park would be killed. The new biological station of the International Biological Programme in Bonne Bay was situated there precisely because the fjord is unpolluted.

In early March 1970, it was discovered that the latest delaying ploy of the Provincial Government is the granting of some 320,000 acres of oil-exploration concessions within the boundaries of the proposed park. This area has been prospected and drilled for oil for over 75 years by at least five different companies, but no commercially-usable deposits have ever been found. The company granted the oil concessions is a part of the same cartel to which the Provincial government has granted the exploitation rights to most of the timber resources of Labrador.

There has been an inordinate amount of double-talk by provincial politicians during the history of the struggles to establish this National Park. Provincial politicians have stated publicly that negotiations with Federal officials were completed, when in fact they were not. Provincial politicians have stated that no cutting is allowed on land destined for the Park yet during the winter '68-69 some 50 cutting permits were issued in the Bonne Bay region alone. The proposals repeated in this present article have been distorted by provincial politicians in their public statements so that the new park was made to stretch all the way across the Northern Peninsula. Provincial politicians have also made a chauvinistic play to the pride of Newfoundlanders in their provincial wildlife policies versus National Park wildlife policies. Provincial politicians have talked about the land being "given away" to the federal government for a National Park. They forget that such land is saved for *all* the people. The real give-away

would come with a mine or pulp-cutting when the profits from the peoples' land would be given to the shareholders in New York or Boston or London and the people would get only a few crumbs left over. Mines are run for profit but parks are run for people.

In this vein I should mention that the "wilderness areas" in the centre of the island and on the Avalon Peninsula, which look so impressive on the maps sent by the Provincial government to prospective tourists, are, to put it bluntly, fakes. By no stretch of the imagination do they possess the minimum protection to be classified as Wilderness Areas, since they have been, and are at present, subject to impoundment, watershed diversion and other acts of blatant exploitation.

In my experience, controversy in the establishment of a new National Park usually has the local level of government *for* the park and the local populace *against* the new park. The situation in the Long Range National Park controversy is just the reverse. By far the majority of the people on the western shore of Newfoundland are solidly behind my proposals for a National Park that would be not only worthy of the name but also world-famous. The leaders among the local people have a splendid organization, the Northern Regional Development Association, which is actively working for the establishment of a great Park. So high is the enthusiasm this organization has nurtured that some 700 people attended a public meeting in Woody Point on 1 March 1969.

The biology and economics are straightforward for a park with boundaries approximating my proposals. The next step, clearly, is to bring public pressure to bear on the governmental agencies responsible, both Federal and Provincial. Because of the peculiar sensitivity and chauvinism of Newfoundland politicians, non-Newfoundlanders should follow a different line of attack than that open to natives of the island.

If you are a Newfoundlander, I see two very useful courses available. First you should join and become active in an already-existing organization that is fighting for the Park. There are two main organizations so engaged: the Northern Regional Development Association and the Newfoundland Natural History Society. Newfoundland pressure must be exerted through groups since the Provincial government has shown itself remarkably insensitive to individual submissions.

The second course is to form your own local "Friends of the Long Range" group. Here you can discuss all aspects of the Park, you can write letters (on your organization's letterhead) to the Provincial government, you can write letters and editorials in your local newspapers, get on local radio and television, etc.

If you are not a Newfoundlander you should employ an entirely different approach. You should channel your efforts to persuading the Federal Parks people to stand firm in their boundaries and not be satisfied with less than a world-famous Park. I frankly think that the civil servants of the National Parks of Canada are not sufficiently aggressive in their efforts to secure a first-rate Park and need to be jogged into realizing that the citizens have progressed far beyond them in the desire for parks.

The Northern Regional Development Association has formally proposed to Bowaters Pulp and Paper Company a moratorium on cutting activity on all lands liable to be included in the Park. I have also proposed that Bowaters Pulp and Paper Company, in appreciation for all it has gained from the people of Newfoundland, donate three-tenths of one percent of their land (the valleys of the Upper Humber and Main rivers) to the people of Newfoundland by ceding the land to the Government of Canada for inclusion in the Long Range National Park. To date, the company response has been polite but non-committal. Perhaps the company could be persuaded?

What both Newfoundlanders and non-Newfoundlanders could all do, to promote not only the Long Range National Park but other parks, is to join and support the National and Provincial Parks Association of Canada[1].

[1]The National and Provincial Parks Association of Canada, 43 Victoria Street, Suite 18, Toronto 1, Ontario. Membership dues: Individual $5.00/year; Husband and wife, $6.50/year. All members receive the quarterly journal PARK NEWS.

Organochlorine Residues in Aquatic Birds in the Canadian Prairie Provinces

KEES VERMEER
Canadian Wildlife Service, Edmonton, Alberta

LINCOLN M. REYNOLDS
Ontario Research Foundation, Sheridan Park, Ontario

Abstract. A survey was conducted of organochlorine residues in 21 aquatic bird species at 31 locations in Alberta, Saskatchewan and Manitoba. As DDT and DDD residue levels from analyses without PCB separation proved to be unreliable, they were omitted from the results. DDE and dieldrin levels were higher in eggs of larids and fish-eating birds than in those of geese and ducks, presumably reflecting different trophic levels between those two groups of birds. Interspecific differences of DDE, dieldrin, HE and β BHC residues observed in larids and fish-eating birds at the same breeding localities may reflect interspecific differences of feeding habits. DDE, dieldrin and PCB levels may be predicted in tissues of California Gull females when known in their eggs. Residue levels in eggs closely resembled those in the livers of females at the time of laying. Shell thickness was significantly and inversely correlated with the concentration of DDE in 40 Great Blue Heron eggs from Alberta, but no significant correlation was found between the concentration of PCBs and shell thickness in those eggs.

Introduction

It has been shown that fish-eating birds in England contained greater average organochlorine residues than any other group of birds examined (Moore and Walker, 1964). J. O. Keith (1966) found that fish-eating birds in California accumulated large residues of insecticides in their body tissues. The results of a study on reproductive success in a Wisconsin population of Herring Gulls, *Larus argentatus*, contaminated with DDT suggested that DDT residues were responsible for the low hatching success of eggs (J. A. Keith, 1966). Reduced shell thickness has been found to be correlated with the amount of DDE in the egg contents of raptors (Hickey and Anderson, 1968; Fyfe *et al.*, 1969) and fish-eating birds (Hickey and Anderson, 1968; Anderson *et al.*, 1969). Experimental studies with Mallards, *Anas platyrhynchos*, showed that DDE can reduce thickness and cause cracking of eggshells (Heath *et al.*, 1969). For these reasons, and as little is known about the extent of organochlorine residues present in aquatic birds of the Canadian prairie provinces, a survey was conducted to determine the type and quantity of organochlorine residues present in aquatic birds, particularly larids and fish-eating birds, in Alberta, Saskatchewan, and Manitoba. Eggs were chosen as samples to be analyzed for organochlorine residues as they are easy to collect and constitute distinct units of comparison between species.

Methods

Seventy composite samples of eggs were collected during egg-laying and incubation from aquatic birds in Alberta and Saskatchewan in 1968 and thirty composite samples of eggs were collected in Saskatchewan and Manitoba in 1969. Each composite sample consisted of 10 eggs, representing one egg from each of 10 nests of the same species. Composite rather than individual samples were collected to reduce costs of analyses. Additionally, in 1969 ten individual egg samples were taken from Common Terns, *Sterna hirundo*, and Double-crested Cormorants, *Phalacrocorax auritus*, and 40 individual egg samples were taken from Great Blue Herons, *Ardea herodias*, to assess variations of pesticide residue levels within nesting colonies. The egg shells of the Great Blue Herons were dried at room temperature for 4½ months before their thickness was measured in order to relate shell thickness to DDE levels in those eggs. Thickness in each case represents the shell itself plus the dried egg membranes. Ten adult California Gulls, *Larus californicus*, were also collected on an Edmonton garbage dump upon arrival during the second week of April, 1969. Ten females of that species and their eggs were taken from their nests at Joseph and Miquelon lakes, 20 and 27 miles respectively from the first collection site, during egg-laying and their first week of incu-

TABLE 1.—DDT and DDD residue levels in ppm wet weight before and after PCB separation in tissues and eggs of female California Gulls.

Tissue sample	No. Sam.	Mean DDT			Mean DDD		
		Before	After	%	Before	After	%
Abdom. fat	10	2.099	0.577	28	1.891	0.064	3
Ovary	10	0.156	0.025	16	0.157	0.025	16
Liver	10	0.066	0.002	3	0.072	0.009	13
Brain	10	0.022	0.001	5	0.023	0.001	4
Eggs	10	0.090	0.028	31	0.073	ND	0

ND = none detected = < 0.0001 ppm

bation in the first week of May, 1969. Gull tissues and eggs were analyzed for the purpose of comparing pesticide residue levels between arriving and incubating gulls as well as between incubating females and their own eggs. One type of tissue analysed was fat, taken from the abdominal cavities of the gulls.

The contents of eggs and bird tissues were stored in glass jars and preserved by freezing.

Laboratory Analysis

For extraction of the organochlorine residues, the frozen egg sample was thawed out and homogenized in a Waring Blender.

An aliquot (2-5 g) of the blend was weighed into a 50 ml beaker to the nearest milligram and dried in a vacuum oven at 45°C with slight vacuum to constant weight (approximately 36 hours needed). The per cent moisture was then calculated from the difference in weights.

After constant weight was obtained, the dried sample was broken up by adding 5-10 g anhydrous Na_2SO_4 and grinding with a flattened glass rod. The dried material was removed from the sides and bottom of the beakers by grinding and scraping. The mixture was poured into a Soxhlet thimble and the beaker rinsed several times with ether : n-hexane (1:1). A glass wool plug was used to cover the sample in the thimble which was then extracted in a Soxhlet apparatus for 2 hours, using about 150 ml of 1:1 ether-hexane mixture at a rate of 10 siphonings per hour.

After extraction, the solvent was removed in a flash evaporator and the dried flask was weighed. The per cent fat was calculated from the difference in weights.

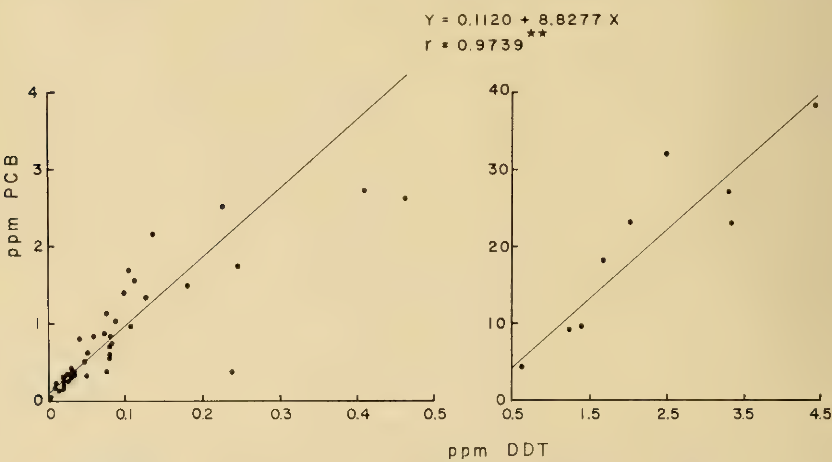


FIGURE 1. Relationship between DDT, before PCB separation, and PCB levels in ppm wet weight (** p <0.01).

TABLE 2.—Mean wet-weight ppm residues of DDE in composite samples of 10 aquatic bird eggs in the prairie provinces.

Sample location	California Gull	Ring-billed Gull	Franklin's Gull	Herring Gull	Common Tern	Double-crested Cormorant	White Pelican
1. Namur Lake	7.69			2.67			1.45
3. L. Therien Lake	6.80	2.48			3.29	8.43 (3.57)*	
4. Chip Lake	9.12	3.63			25.2 (6.38)*		
5. Miquelon Lake	21.6 (7.51)*	2.99					
8. Dowling Lake	9.53	3.95					
10. Lake Newell	10.2	4.82	0.335		11.1	4.58	
11. Murray Lake	6.17	5.06					
13. Kazan Lake	11.3					5.00	2.98
14. Primrose Lake	11.2	5.98			2.04	6.36	1.97
15. Doré Lake	9.77	9.84					
16. Lavallee Lake					13.5	5.55	2.56
17. Montreal Lake					15.9		
18. Suggi Lake		3.31		11.9		4.15	1.46
19. Jackfish Lake		12.3	0.447				
21. Redberry Lake	5.38	5.52				4.22	2.04
22. Old Wives Lake	6.81	1.63				3.47	1.85
23. Cypress Lake	7.86	2.88				5.88	1.76
24. Talbot Lake				17.2		3.88	1.36
25. Moose Lake				14.2		6.13	0.957
26. Lake Winnipegosis		4.18		13.3		3.74	1.17
27. Kawinaw Lake		3.59					1.47
28. Pelican Lake	4.07	2.24		15.5		3.43	0.830
29. Lake Winnipeg (St. Martin Is.)				15 2		5.57	1.37
30. Dog Lake						8.41	1.00
31. Lake Manitoba		1.26				9.00	4.76
	Great Blue Heron	**Black-crowned Night Heron**	**Western Grebe**	**Horned Grebe**	**Eared Grebe**	**American Avocet**	**Coot**
2. Cold Lake			7.76				
4. Chip Lake	37.01						
6. Battle River (Wetaskiwin)	5.71						
7. Jamieson Lake	11.90 (6.61)*						
8. Dowling Lake	6 71						
9. Stobart Lake						3.32	
10. Lake Newell						3.16	0.41
11. Murray Lake		0.90					
12. Belly River (Glenwoodville)	9.95						
19. Jackfish Lake			3.94				
20. Battleford				5.13			
22. Old Wives Lake		2.93			0.55		
27. Kawinaw Lake			3.46				
	Canada Goose	**Mallard**	**Pintail**	**Gadwall**	**American Widgeon**	**Blue-winged Teal**	**Lesser Scaup**
3. L. Therien Lake							0 33
4. Chip Lake				0.23			1.02
5. Miquelon Lake		0.14					
8. Dowling Lake	0.04						
10. Lake Newell	0.03	0.37		0.16	0.09	0.81	0.36
19. Jackfish Lake		0.24					
22. Old Wives Lake		0.24	0.92				
23. Cypress Lake	0.02	1.07					

*Collected in 1969.

TABLE 3.—Mean wet-weight ppm residues of dieldrin in composite samples of 10 aquatic bird eggs in the prairie provinces

Sample location	California Gull	Ring-billed Gull	Franklin's Gull	Herring Gull	Common Tern	Double-crested Cormorant	White Pelican
1. Namur Lake	ND			0.012			0.113
3. L. Therien Lake	0.030	0.331			0.063	0.414 (0.112)*	
4. Chip Lake	0.039	0.364			0.075 (0.038)*		
5. Miquelon Lake	ND (0.059)*	0.284					
8. Dowling Lake	0.048	0.415					
10. Lake Newell	ND	0.260	0.314		0.396	0.172	
11. Murray Lake	1.52	0.320					
13. Kazan Lake	0.051					0.652	0.131
14. Primrose Lake	0.048	0.788			0.017	0.360	0.383
15. Doré Lake	1.38	0.425					
16. Lavallee Lake					0.144	0.266	0.133
17. Montreal Lake					0.130		
18. Suggi Lake		0.453		0.318		0.270	0.184
19. Jackfish Lake		0.912	0.284				
21. Redberry Lake	0.034	0.726				0.498	0.082
22. Old Wives Lake	0.044	0.288				0.205	0.087
23. Cypress Lake	0.057	0.409				0.068	0.054
24. Talbot Lake				0.478		0.366	0.127
25. Moose Lake				0.438		0.642	0.096
26. Lake Winnipegosis		0.614		0.442		0.380	0.103
27. Kawinaw Lake		1.27					0.176
28. Pelican Lake	0.065	1.11		0.514		0.305	0.087
29. Lake Winnipeg (St. Martin Is.)				0.496		0.681	0.099
30. Dog Lake						0.542	0.084
31. Lake Manitoba		0.442				0.330	0.179
	Great Blue Heron	**Black-crowned Night Heron**	**Western Grebe**	**Horned Grebe**	**Eared Grebe**	**American Avocet**	**Coot**
2. Cold Lake			ND				
4. Chip Lake	0.111						
6. Battle River (Wetaskiwing)	0.077						
7. Jamieson Lake	0.344 (0.119)*						
8. Dowling Lake	0.056						
9. Stobart Lake						0.171	
10. Lake Newell						0.252	
11. Murray Lake		0.026					0.004
12. Belly River (Glenwoodville)	0.236						
19. Jackfish Lake			ND				
20. Battleford				ND			
22. Old Wives Lake		0.139			0.002		
27. Kawinaw Lake			0.128				
	Canada Goose	**Mallard**	**Pintail**	**Gadwall**	**American Widgeon**	**Blue-winged Teal**	**Lesser Scaup**
3. L. Therien Lake							0.020
4. Chip Lake				0.027			0.169
5. Miquelon Lake		0.038					
8. Dowling Lake	0.012						
10. Lake Newell	0.022	0.020		0.025	0.032	0.027	0.022
19. Jackfish Lake		0.063					
22. Old Wives Lake		0.080	0.050				
23. Cypress Lake	0.012	0.050					

*Collected in 1969.

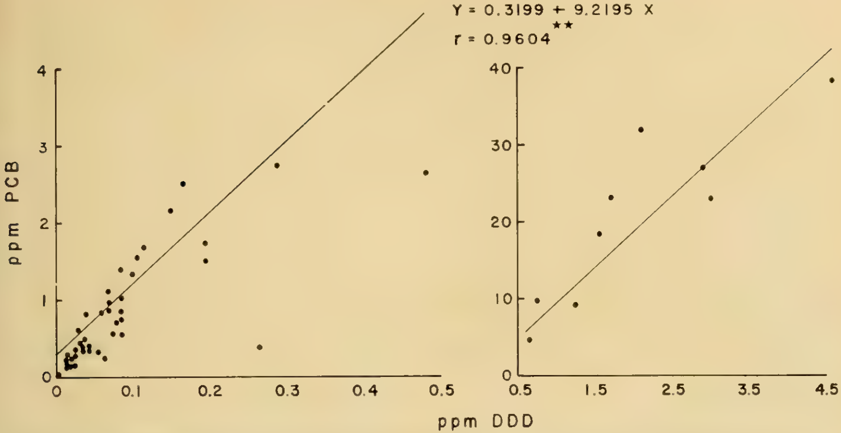


FIGURE 2. Relationship between DDD, before PCB separation, and PCB levels in ppm wet weight.

TABLE 4. — Mean wet-weight ppm residues of HE in composite samples of 10 aquatic bird eggs in the prairie provinces

Sample location	California Gull	Ring-billed Gull	Herring Gull	Double-crested Cormor.	White Pelican	Great Blue Heron	Mallard
3. L. Therien Lake				0.016			
4. Chip Lake						0.071	
5. Miquelon Lake	0.015						
6. Battle Riv. (Wetaskiwin)						0.007	
7. Jamieson Lake						0.015	
12. Belly Riv. (Glenwoodville)						0.040	
22. Old Wives Lake	0.020	0.043		0.033	ND		0.009
23. Cypress L.	0.027	0.246 (0.008)*		0.015	0.018		0.902 (0.067)*
24. Talbot L.			0.167	0.032	0.015		
25. Moose L.			0.146	0.075	0.010		
26. Lake Winnipegosis		0.045	0.043	0.022	0.022		
27. Kawinaw Lake		0.127			0.022		
28. Pelican L.	0.009	0.142	0.134	0.022	0.023		
29. Lake Winnipeg (St. Martin Is.)			0.114	0.074	0.018		
30. Dog Lake				0.028	0.011		
31. Lake Manitoba		0.035		0.044	0.017		

*Heptachlor.

TABLE 5.—Mean wet-weight ppm residues of β-BHC in composite samples of 10 aquatic bird eggs in the prairie provinces

Sample location	California Gull	Ring-billed Gull	Herring Gull	Double-crested Cormor.	White Pelican	Great Blue Heron	Mallard
3. L. Therien				0.065			
4. Chip Lake						0.082	
5. Miquelon Lake	ND						
6. Battle Riv. (Wetaskiwin)						0.008	
7. Jamieson Lake						0.020	
12. Belly Riv. (Glenwoodville)						0.028	
22. Old Wives Lake	ND	ND		ND	ND		ND
23. Cypress L.	ND	ND		ND	ND		ND
24. Talbot L.			ND	0.230	ND		
25. Moose L.			ND	0.176	ND		
26. Lake Winnipegosis		ND	ND	0.167	ND		
27. Kawinaw Lake		0.040			0.032		
28. Pelican L.	ND	0.028	ND	0.170	ND		
29. Lake Winnipeg (St. Martin Is.)			0.035	0.280	ND		
30. Dog Lake				0.208	ND		
31. Lake Man.		ND		0.200	ND		

The fat residue was dissolved in 150 ml of 5% benzene in acetone and the solution was cleaned-up by cold precipitation, essentially according to the method of McCully and McKinley (1964). The solution was chilled to —70°C and stirred for 35 minutes in a dry ice-methanol cold bath. The mixture was then filtered through a carbon-celite (2 g: 10 g) pad at —70°C dried with Na_2SO_4, concentrated and made to a volume of 5 ml with hexane. Additional cleanup was effected by use of a Florisil column and the cleaned-up extract was analysed for pesticide residues by gas liquid chromatography-electron capture (GLC-EC) technique with parameters as described by Reynolds (1969).

FIGURE 3. Sample locations of aquatic bird eggs in Alberta, Saskatchewan and Manitoba.

The compounds screened for were lindane, heptachlor, aldrin, kelthane, DDE, dieldrin, DDD, o,p′-DDT, p,p′-DDT, methoxychlor, endrin and tedion in 1968 and in addition heptachlor epoxide (HE) and benzene hexachloride (α-, β-, and γ-BHC) in 1969.

No corrections were made for pesticide losses during the extraction and cleanup processes, although recovery studies for 8 of the more common pesticides showed an average loss of about 10%. Confirmation of specific residues was made by use of more polar phase GLC columns, derivatization and use of characteristic

GLC retention times of the derivatives, and by thin layer chromatography where possible.

A number of samples were analysed for polychlorobiphenyls (PCBs) as these compounds interfere with the organochlorine pesticide analyses. The PCBs were separated from the organochlorine pesticides by differential elution from a Florisil column and estimated by the methed of Reynolds (in press). The PCB values reported are based on Aroclor 1254 and are the averages of the calculation for peaks No. 8 and 10, two of the major peaks in the PCB commercial mixture. It can be seen that DDT and DDD residue levels obtained in 50 California Gull tissues without prior PCB separation are unreliable (Table 1). An increase in those levels can be significantly correlated with a greater PCB contamination (Figures 1 and 2). As the DDT and DDD levels obtained without PCB separation are unreliable and as they constituted only a small fraction of the total DDT plus metabolite contamination, they have been omitted from the results.

The DDE values presented may include small contributions from PCBs since DDE is not separated from a minor PCB interfering peak. However, if the GLC pattern of a sample extract (prior to PCB separation on Florisil) shows high "apparent" DDE with little or no DDD and DDT present, then all or most of the apparent DDE is probably "true" DDE. It should be noted that almost all the samples, with the exception of the fat tissues, showed less than one ppm DDT or DDD prior to PCB separation, thus indicating that PCB contributions to the DDE values are likely to be small.

No standard method was found in the literature to represent quantities of organochlorine residues in tissues. In this paper, the pesticide residues are shown in ppm wet weight as most articles relating to pesticides appear to follow this procedure. As loss of moisture from eggs during incubation tends to concentrate organochlorine residues in the growing embryo, and as there are interspecific differences in the moisture percentage of eggs it may be more accurate to present residues on a dry-weight basis. For those who want to convert the residues from wet to dry or lipid weight in ppm, the percentage moisture and fat of each pooled egg sample is shown in the appendix.

Results and Discussion

Survey of Pooled Egg Samples

The numbers in Figure 3 denote the locations where the egg samples were collected and relate to those in Tables 2, 3, 4, and 5. Samples were taken in Alberta and Saskatchewan in 1968, except for Cypress and Old Wives Lakes, and at those two lakes and in Manitoba in 1969. Collections were made at certain locations in Alberta in both years. Table 2 shows the DDE residue levels present in aquatic bird eggs. The eggs of larids (except Franklin's Gull, *Larus pipixcan*) and those of fish-eating birds such as the Double-crested Cormorant, White Pelican, *Pelecanus erythrorhynchos,* Great Blue Heron, and Western Grebe, *Aechmophorus occidentalis,* contained the highest DDE levels, while waterfowl egg levels were generally the lowest. This difference may simply reflect feeding habits and biological magnification of DDE, for the plant and small animal food of the waterfowl can be reliably expected to contain lower concentrations of DDE than the larger animal food of the larids and fish-eating birds.

Within larids, the generally higher DDE residue levels in the eggs of California Gulls than in those of Ring-billed Gulls, *Larus delawarensis,* may also result from a difference in diet, since California Gulls eat on the average larger rodents and are greater scavengers than Ring-billed Gulls (Vermeer, 1967).

For Franklin's Gulls, the average DDE residue level found in the present study is similar to the 0.462 ppm wet weight reported for 30 eggs of Franklin's Gulls at Hay Lakes, Alberta, in 1966 (Guay, 1968). The relatively low residue levels in the eggs of Franklin's Gulls may be related to their dominantly insectivorous diet. Guay (1968) found that the Franklin's Gull diet consisted of 88% insects. No vertebrates were present in the stomachs of the 27 Franklin's Gulls examined by him. The diet of California and Ring-billed Gulls in contrast includes large quantities of rodents (Vermeer, 1967).

TABLE 6.—Means and 95% confidence intervals of organochlorine insecticide residues in tissues of California Gulls collected in the vicinity of Edmonton; 10 during spring arrival and 10 during egg-laying in 1969

Tissue analized	Time collected	% Fat in tissue	Residues in ppm wet weight		
			DDE	Dieldrin	HE
Abdominal fat	Arrival	67.8±7.4	211.62±141.53	1.01±0.43	0.68±1.31
	Egg-laying	68.6±8.8	134.11± 91.20	1.16±0.40	0.31±0.25
Liver	Arrival	4.1±1.0	7.73± 6.53	0.09±0.05	0.02±0.02
	Egg-laying	4.0±0.6	5.37± 3.29	0.08±0.04	0.01±0.01
Brain	Arrival	7.3±0.4	2.14± 1.43	0.02±0.01	0.0007*
	Egg-laying	6.9±0.5	1.31± 0.74	0.02±0.01	0.0011*

*HE observed in < 3 samples.

The Herring Gull, like the California Gull, is a scavenger, but the former appears to eat more fish in its inland habitat (Mendall, 1939; Ludwig, 1962). The DDE residue levels observed in the eggs of this species at the large Manitoba lakes may be a reflection of its diet. J. A. Keith (1966) associated Herring Gull egg levels averaging 202 ppm wet-weight DDE with exceptionally low hatching success in northern Lake Michigan, and the lower 95% confidence limit of this average was 122 ppm, seven times higher than the highest Herring Gull level reported here.

No quantitative data on the food habits of Common Terns, in the prairie provinces are available. The diet of this species on the Maine coast chiefly consists of fish and crustaceans (Mendall, 1935). The DDE levels in the eggs of this species at different breeding locations appear to vary more than in the other larids.

The higher residue levels found in the eggs of Double-crested Cormorants than in those of White Pelicans may be related to their different feeding habits. White Pelicans scoop fish from the water surface (Hall, 1925) while Double-crested Cormorants obtain fish by diving (Bartholomew, 1942). Anderson *et al.* (1969) found similar differences in DDE residues between those two species in Minnesota, Wisconsin, North Dakota, Manitoba and Saskatchewan. They explain them as being a result of dissimilar non-breeding area exposures. According to their calculations, based on information from Bent (1922), Lewis (1929), Mendall (1936), and refuge personnel, pelicans arrive on the average on April 10 and cormorants on May 3. However, Lewis (1929: 14) states that

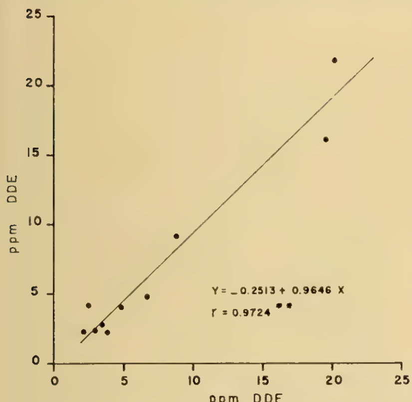
TABLE 7.—Variation of DDE residues in ppm wet weight in individual samples of 10 aquatic bird eggs in Alberta in 1969.

Species	Where Collected	Mean	Range	Coefficient of Variation
Great Blue Heron	Belly River (Glenwoodville)	9.95	1.5 – 24.0	61.83
Great Blue Heron	Battle River (Wetaskiwin)	5.71	1.4 – 13.5	69.96
Great Blue Heron	Jamieson Lake	6.61	1.0 – 31.8	138.68
Great Blue Heron	Chip Lake	37.01	0.7 – 234.4	197.73
Common Tern	Chip Lake	6.38	1.2 – 33.3	151.93
California Gull	Miquelon and Joseph Lakes	7.51	2.1 – 20.2	91.09
Double-crested Cormorant	L. Therien Lake	3.57	1.5 – 6.4	41.65

cormorants in Manitoba may arrive at the end of March or early April. From eight average arrival dates each (Lewis 1929: 16), we calculate that cormorants arrive on average in Minnesota, Wisconsin and North Dakota on April 17 and in Manitoba on April 24. One of us (KV) watched the spring arrival of cormorants at Cypress Lake, Saskatchewan, in 1969 and at Lake Newell, Alberta, in 1968 and 1969. Cormorants occupied their nesting grounds by mid-April, even before ice disappeared from those lakes, and initiated egg-laying during the last week of April (Vermeer, 1970; in press). KV also observed little or no interspecific difference in hatching dates where the two species nested together in large numbers in the Canadian prairie provinces. Hence it appears that the interspecific differences in DDE residues cannot be explained on the basis of dissimilar spring arrival dates. Different food habits on the breeding and/or non-breeding grounds is a more likely explanation for dissimilar DDE contamination of the two species.

The dieldrin residue levels in the aquatic bird eggs are shown in Table 3. Although the dieldrin levels are not as high as those of DDT compounds, their effects are not less serious. DeWitt *et al.* (1960) tested the toxicity of 21 insecticides to Bobwhite Quail, *Colinus virginianus*, and found dieldrin to be 14 times more toxic than DDT. As has been observed for the DDE residues, the eggs of larids and fish-eating birds contain more dieldrin than those of waterfowl, while cormorants appear to be more contaminated than pelicans.

HE is of similar toxicity as dieldrin to birds (Moore, 1965). HE is rapidly metabolized from heptachlor and hence the latter is rarely



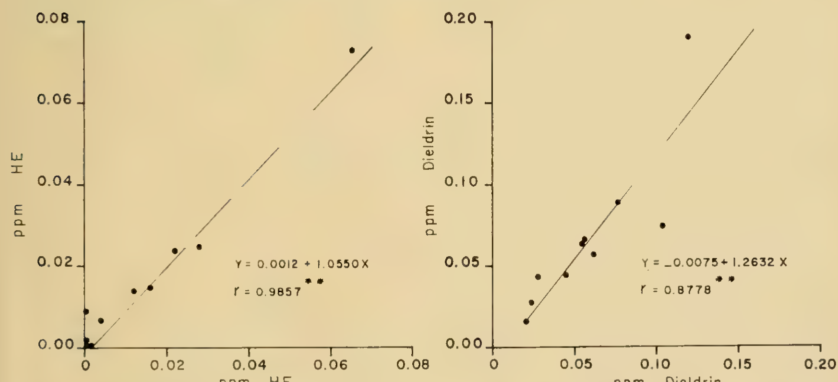


FIGURE 4. Relationships of organochlorine residue levels within pairs of eggs from 10 California Gull clutches; points being intersections of pair values.

TABLE 8. Means and 95% confidence intervals of organochlorine insecticide residues in tissues and single eggs of 10 California Gull females at Miquelon and Joseph Lakes, Alberta in 1969.

Tissues	Per cent		ppm wet weight		
	Fat	Non-fat (water excl.)	DDE	Dieldrin	HE
Abdominal fat	68.6±8.8	7.4±3.2	134.11±91.20	1.16±0.40	0.31 ±0.25
Ovary	11.4±3.6	17.7±1.1	12.56± 9.33	0.15±0.12	0.019±0.016
Egg	7.8±1.0	16.1±0.5	7.26± 4.84	0.06±0.03	0.016±0.015
Liver	4.0±0.6	26.3±0.8	5.37± 3.29	0.08±0.04	0.009±0.008
Brain	6.9±0.5	13.9±1.1	1.31± 0.74	0.02±0.01	0.001

detected as a residue. But heptachlor was still present where high HE residue levels were found in Ring-billed Gull and Mallard eggs at Cypress Lake (Table 4). It can be seen in Table 5 that Herring and Ring-billed Gulls are more contaminated with HE than cormorants and pelicans, while cormorants in turn have higher average HE levels than pelicans.

Table 5 shows that the cormorants at the lakes in Manitoba are most contaminated with β BHC residues. Eggs of White Pelicans, Herring and Ring-billed Gulls contained lower β BHC residues at the same locations. Perhaps β BHC is associated with the fish on which cormorants feed.

Nothing is known concerning the source of the organochlorine residues in the aquatic birds. We compared residue levels from tissues of 10 California Gulls collected near Edmonton at spring arrival with those of 10 birds of that species taken at Joseph and Miquelon Lakes during egg-laying and the first few days of incubation in 1969 (Table 6). Although there are no statistically significant changes in residue levels between gulls from those two time periods, a trend indicates a residue decline of DDE in gulls with the advancing season. This suggests that food taken during spring migration or during the winter contained higher levels of DDT or DDE than food taken during the early breeding season.

In order to reduce costs of residue analyses, composite egg samples were usually analyzed. However, ten individual eggs, of various species from several localities in Alberta in 1969, were also analyzed to determine DDE residue variation within local populations (Table 7). It can be seen that the DDE levels vary considerably within eggs of local breeding populations of Great Blue Herons, California Gulls and Com-

TABLE 9.—DDE and dieldrin residue ratios in tissues and single eggs of 10 California Gull females at Joseph and Miquelon Lakes, Alberta in 1969.

Tissue comparisons	DDE		Dieldrin	
	Mean ratios ± SE	Coefficient of correlation	Mean ratios ± SE	Coefficient of correlation
Fat/egg	19.6±3.3	0.9506**	20.3±2.8	0.8073*
Liver/egg	0.81±0.12	0.9242**	1.48±0.29	0.3612
Brain/egg	0.20±0.03	0.9285**	0.27±0.04	0.9366**
Ovary/egg	1.76±0.20	0.8539**	2.21±0.05	0.4327

*$p < 0.05$
**$p < 0.01$

TABLE 10.—DDE and dieldrin residue ratios in tissues of 20 California Gulls from Edmonton and Joseph and Miquelon Lakes, Alberta in 1969.

Tissue comparisons	DDE		Dieldrin	
	Mean ratios ± SE	Coefficient of correlation	Mean ratios ± SE	Coefficient of correlation
Fat/liver	30.8±3.8	0.9553**	16.4±2.1	0.4760*
Fat/brain	107.5±9.4	0.9172**	73.3±9.8	0.8570**
Liver/brain	3.78±0.24	0.9286**	5.78±0.81	0.7284**

mon Terns. Although one highly contaminated gull, heron or tern may bias a mean composite sample, nevertheless a pooled sample is better than a single sample as an indicator of the degree of organochlorine contamination of a population. Two Great Blue Heron eggs with 78.0 and 234.4 DDE residue levels at Chip Lake, for example, had the highest DDE levels of all aquatic bird eggs collected. If one egg, low in DDE residues, had been sampled, there would be no indication that some herons at that locality were highly contaminated.

The variation in individual DDE residue levels was smaller in Double-crested Cormorants than in Great Blue Herons, California Gulls and Common Terns (Table 7). Intraspecific variation in mean DDE residues between different localities was also smaller in cormorants, as well as in pelicans, than in California Gulls, Ring-billed Gulls, Common Terns, Herring

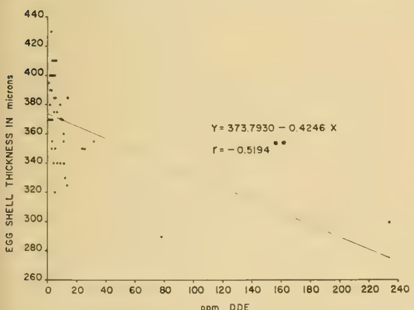


FIGURE 5. Relation between DDE concentrations and shell thickness in forty Great Blue Heron eggs from four Albertan heronries in 1969.

Gulls and Great Blue Herons (Table 2). This may be related to the almost exclusively fish diet of cormorants as compared to the only partly fish diet of the gulls and herons. Cormorants probably are more restricted to feeding in deeper waters than terns, which have been observed feeding in very shallow bays as well as in ponds adjacent to the lakes where they nest.

Eggs as Indicators

Two eggs of each of 10 clutches of California Gulls at Joseph and Miquelon Lakes were taken in 1969 to determine if organochlorine residue levels in one egg were representative of those in other eggs laid by the same female. It can be seen that they were representative as there are highly significant correlations of residue levels between eggs of the same clutch (Figure 4). A comparison is also made between the organochlorine insecticide residue levels in tissues and in single eggs of 10 California Gull females during the egg-laying period (Table 8). As residue levels of eggs and livers were the most alike of all the tissues examined, those in eggs are approximate indicators of those in livers of females at the time of egg-laying. It can be seen that the residue levels in the abdominal fat are significantly higher than those in the ovary, egg, and liver, and that the levels of those tissues in turn are significantly higher than in the brain of the same birds. As organochlorine residues tend to dissolve and concentrate in fat, the tissues with most fat generally have the highest residue levels. There are exceptions, however, for while the brain contains a significantly higher percentage of fat than the liver, nevertheless the liver has a significantly higher DDE and dield-

TABLE 11.—Means and 95% confidence intervals of PCB residues in tissues and single eggs of 10 California Gull females at Joseph and Miquelon Lakes, Alberta in 1969.

Tissues	Per cent		PCB in ppm wet weight
	Fat	Non fat (water excluded)	
Abdominal fat	68.6±8.8	7.4±3.2	18.87±8.57
Ovary	11.4±3.6	17.7±1.1	1.22±0.65
Egg	7.8±1.0	16.1±0.5	0.87±0.39
Liver	4.0±0.6	26.3±0.8	0.79±0.36
Brain	6.9±0.5	13.9±1.1	0.29±0.16

rin level than the brain (Table 8). Hence residue comparisons between different tissues on a lipid basis may be sometimes misleading.

Residue levels in tissues of California Gull females are compared with those in their eggs (Table 9). As HE residues were not observed in many samples, they have been excluded from the table. Highly significant correlations can be observed in DDE levels between tissues and eggs. Dieldrin levels in the fat and brain also relate significantly to those in eggs. DDE and dieldrin ratios appear to be of similar magnitude for the same tissue comparisons. Hence, as the correlations are generally significant, DDE and dieldrin residue levels in tissues of California Gulls at the time of egg-laying may be predicted when known in their eggs. They may also be predicted when known in another tissue than eggs (Table 10).

PCB residue levels in tissues of California Gull females are also compared with those in their eggs (Tables 11 and 12). It can be seen that the distribution of PCB residues in tissues follows the same trend as those for DDE, dieldrin and HE (Tables 8), and that the pattern of PCB residue ratios also follows the same trend as those for DDE and dieldrin (Table 9). Hence PCB residue levels in egg-laying California Gulls may be predicted when known in their eggs, and for birds generally, PCB residues may prove to have a tissue distribution pattern similar to the patterns of DDE, dieldrin, and HE.

TABLE 12.—PCB residue ratios in tissues of 10 California Gull females and their eggs at Joseph and Miquelon Lakes, Alberta in 1969.

Tissue comparisons	Mean ratio ± SE	Coefficient of correlation
Fat/egg	25.45±6.32	0.7558*
Liver/egg	1.11±0.27	0.6159*
Brain/egg	0.38±0.09	0.6274*
Ovary/egg	1.67±0.38	0.7127*

Figure 5 shows a highly significant inverse correlation between shell thickness and DDE residues in 40 Great Blue Heron eggs from heronries at the Battle River near Wetaskiwin, the Belly River near Glenwoodville, Chip Lake, and Jamieson Lake in Alberta. The DDE residues are shown in ppm wet weight to maintain uniform presentation of results. Somewhat better correlations between DDE residues in eggs and egg shell thickness of herons were observed on a dry-weight (r = —0.5741**) and a lipid-weight basis (r = −0.5958**). Hence more significant correlations may be obtained by means of the latter methods when comparing organochlorine residues within the same tissues. Although a linear regression is shown in Figure 5, the relation between DDE residues in eggs and egg shell thickness was

TABLE 13.—Relation between DDE residue levels and embryonic development in Great Blue Heron eggs collected at Chip Lake on May 28, 1969

ppm DDE in wet wt.	% water in eggs	Condition of embryo in collected egg	No. eggs and/or young per nest
0.713	84	Embryo alive	5
2.17	83	Embryo alive	4
2.74	84	Embryo alive	5
4.00	80	No development (infertile?)	4
4.62	84	Embryo alive	5
6.59	82	Embryo alive	4
11.1	83	Embryo alive	4
25.8	83	Embryo alive (pipping)	5
78.0	82	Embryo alive (pipping)	4
234.4	73	Embryo died at early stage	1

slightly curvilinear, fitting an exponential curve $y = (374.081)\ (0.9987)^x$. However, more egg samples with high DDE residue contents are needed to determine whether the actual relationship between DDE residues in eggs and shell thickness is a curvilinear or a linear one.

In contrast with DDE, no significant correlation ($r = -0.1692$) was found between shell thickness and PCB residues in the contents of the 40 Great Blue Heron eggs.

The heron eggs most contaminated with DDE were found at Chip Lake. It can be seen than an embryo from an egg with 78.0 ppm DDE shows development at least until hatching (Table 13). The embryo from an egg with 234.4 ppm DDE died at an early stage, perhaps as a result of the DDE concentration.

Acknowledgments

J. A. Keith was most helpful in his critical review of the manuscript. R. Isbister, J. E. Polson, and S. G. Sealy, assisted in the collection of egg samples.

Literature Cited

Anderson, D. W., J. J. Hickey, R. W. Risebrough, D. F. Hughes and **R. E. Christensen.** 1969. Significance of chlorinated hydrocarbon residues to breeding pelicans and cormorants. Canadian Field-Naturalist, 83: 91-112.

Bartholomew, G. A. 1942. The fishing activity of Double-crested Cormorants in San Francisco Bay. Condor, 44: 13-21.

Bent, A. C. 1922. Life histories of North American petrels and pelicans and their allies/Order Tubinares and Steganopodes. U.S. National Museum Bulletin 121. 343 pp.

DeWitt, J. B., C. M. Menzie, V. A. Adomaitis and **W. L. Reichel.** 1960. Pesticidal residues in animal tissues. Transactions Twenty-fifth North American Wildlife Conference, 277-285.

Fyfe, R. W., J. Campbell, B. Hayson and K. Hodson. 1969. Regional population declines and organochlorine insecticides in Canadian Prairie Falcons. Canadian Field-Naturalist, 83: 191-200.

Guay, J. W. 1968. The breeding biology of Franklin's Gull (*Larus pipixan*). Unpublished Ph.D. Thesis, University of Alberta, Edmonton, 129 pp.

Hall, E. R. 1925. Pelicans versus fishes in Pyramid Lake. Condor 27: 147-160.

Heath, R. G., J. W. Spann and **J. F. Kreitzer.** 1969. Marked DDE impairment of mallard reproduction in controlled studies. Nature 224: 47-48.

Hickey, J. J. and **D. W. Anderson.** 1968. Chlorinated hydrocarbons and egg shell changes in raptorial and fish-eating birds. Science 162: 271-273.

Keith, J. A. 1966. Reproduction in a population of Herring Gulls (*Larus argentatus*) contaminated by DDT. Journal of Applied Ecology, 3, Supplement: 57-70.

Keith, J. O. 1966. Insecticide contamination in wetland habitats and their effect on fish-eating birds. Journal of Applied Ecology, 3, Supplement: 71-85.

Lewis, H. F. 1929. The natural history of the Double-crested Cormorant (*Phalacrocorax auritus auritus*) (Lesson). Ru-Mi-Lou Books, Ottawa. 94 pp.

Ludwig, J. P. 1962. A survey of the gull and tern populations of Lakes Huron, Michigan and Superior. Jack-Pine Warbler 40: 104-119.

McCully, K. A. and **W. P. McKinley.** 1964. Determination of chlorinated pesticide residues in fat by electron capture gas chromatography. Journal of Association of Official Agricultural Chemists 47: 652-659.

Mendall, H. L. 1935. The relationship of certain sea birds to the fishing industry of the State of Maine. Bulletin of the Department of Sea and Shore Fisheries, Maine. 27 pp.

————. 1936. The home-life and economic status of the Double-crested Cormorant (*Phalacrocorax auritus auritus*) (Lesson). University of Maine Studies Second Series, Number 38 (Maine Bulletin 39). 159 pp.

————. 1939. Food habits of the Herring Gull in relation to fresh-water game fishes in Maine. Wilson Bulletin 51: 223-226.

Moore, N. W. 1965. Environmental contamination by pesticides, pp. 219-237. *In* G. T. Goodman *et al.*, (Ed.), Ecology and the Industrial Society, Oxford.

————. and **C. H. Walker.** 1964. Organochlorine insecticide residues in wild birds. Nature, 201: 1072-1073.

Reynolds, L. M. 1969. Polychlorobiphenyls (PCB's) and their interference with pesticide residue analysis. Bulletin of Environmental Contamination and Toxicology 4: 128-143.

————. (In press). Pesticide residue analysis in the presence of polychlorobiphenyls (PCB's). Residue Reviews 34.

Vermeer, K. 1967. A study of two species of gulls, *Larus californicus* and *L. delawarensis*, breeding in an inland habitat. Unpublished Ph.D. Thesis, University of Alberta, 128 pp.

————. 1970. Some aspects of the nesting of Double-crested Cormorants at Cypress Lake, Saskatchewan in 1969; A plea for protection. Blue Jay 28: 11-13.

————. (In press). Arrival and clutch initiation of Double-crested Cormorants at Lake Newell, Alberta.

Received June 18, 1970
Accepted July 8, 1970

APPENDIX.—Percentage moisture (percentage fat in parenthesis) in composite samples of 10 aquatic bird eggs in the prairie provinces

Sample location	California Gull	Ring-billed Gull	Franklin's Gull	Herring Gull	Common Tern	Double-crested Cormorant	White Pelican
1. Namur Lake	77.2 (7.9)			76.8 (7.5)			81.9 (4.9)
3. L. Therien Lake	77.3 (8.6)	75.6 (9.1)			76.3 (10.0)	85.3 (3.0)	
4. Chip Lake	76.7 (8.0)	75.8 (9.8)			77.2 (8.7)		
5. Miquelon Lake	76.5 (10.0)	75.9 (9.6)					
8. Dowling Lake	75.6 (9.6)	75.7 (9.6)					
10. Lake Newell	76.1 (8.9)	76.0 (9.8)	75.0 (8.7)		75.9 (10.0)	83.9 (4.1)	
11. Murray Lake	76.6 (9.3)	74.8 (9.5)					
13. Kazan Lake	76.1 (8.8)					84.3 (4.0)	81.6 (4.0)
14. Primrose Lake	76.0 (8.4)	75.1 (8.0)			75.9 (10.1)	84.2 (3.9)	81.9 (4.9)
15. Doré Lake	77.0 (8.3)	75.2 (9.2)					
16. Lavallee Lake					76.2 (8.8)	83.8 (4.6)	83.7 (5.4)
17. Montreal Lake					77.8 (8.7)		
18. Suggi Lake		76.0 (9.1)		76.4 (7.9)		84.9 (2.9)	82.7 (4.9)
19. Jackfish Lake		76.9 (7.9)	76.9 (8.1)				
21. Redberry Lake	76.8 (8.4)	75.3 (9.6)				84.8 (3.8)	82.9 (3.9)
22. Old Wives Lake	75.0 (7.7)	75.3 (9.0)				84.4 (3.3)	83.0 (3.3)
23. Cypress Lake	75.3 (8.0)	74.4 (8.3)				84.7 (4.0)	83.0 (4.7)
24. Talbot Lake				77.0 (8.0)		84.0 (4.3)	80.7 (2.7)
25. Moose Lake				75.0 (8.0)		84.3 (3.7)	81.7 (4.3)
26. Lake Winnipegosis		75.7 (9.0)		75.7 (8.0)		84.7 (4.0)	81.7 (5.0)
27. Kawinaw Lake		74.3 (9.3)					82.3 (4.7)
28. Pelican Lake	76.0 (8.0)	77.0 (8.7)		75.7 (8.7)		84.0 (3.3)	82.7 (4.7)
29. Lake Winnipeg (St. Martin Is.)				75.7 (8.3)		83.3 (3.7)	82.3 (5.0)
30. Dog Lake						84.3 (3.0)	80.7 (5.3)
31. Lake Manitoba		75.0 (9.3)				84.0 (4.0)	82.7 (5.0)

Sample location	Great Blue Heron	Black-crowned Night Heron	Western Grebe	Horned Grebe	Eared Grebe	American Avocet	Coot
2. Cold Lake			77.8 (8.9)				
4. Chip Lake	81.9 (4.8)						
6. Battle River (Wetaskiwin)	82 1 (5.1)						
7. Jamieson Lake	81.7 (5.8)						
8. Dowling Lake	82.6 (4.9)						
9. Stobart Lake						74.0 (10.9)	
10. Lake Newell						73.6 (11.3)	66.0 (8.8)
11. Murray Lake		81.1 (5.1)					
12. Belly River (Glenwoodville)	81.8 (5.2)						
19. Jackfish Lake			78.5 (6.8)				
20. Battleford				80.1(5.8)			
22. Old Wives Lake		81.3 (5.0)			78.8 (8.0)		
27. Kawinaw Lake			78.0 (7.7)				

Sample location	Canada Goose	Mallard	Pintail	Gadwall	American Widgeon	Blue-winged Teal	Lesser Scaup
3. L. Therien Lake							67.4 (16.1)
4. Chip Lake				66.9 (16.0)			65.5 (15.2)
5. Miquelon Lake		68.1 (14.8)					
8. Dowling Lake	68.6 (15.6)						
10. Lake Newell	69.1 (15.8)	68.0 (15.9)		67.9 (16.0)	68.2 (16.4)	68.9 (14.8)	68.1 (14.9)
19. Jackfish Lake		68.6 (14.3)					
22. Old Wives Lake		68.3 (12.7)	69.7 (12.7)				
23. Cypress Lake	66.4 (15.7)	68.6 (14.7)					

NB The decrease in the % moisture and the increase in the % fat in eggs in the order cormorants – pelicans – herons – grebes – larids – shorebirds (avocets) – ducks and geese may reflect interspecific relations within and differences between avian orders.

Populations of Breeding Birds in the Spruce-Fir Forests of Northwestern Ontario

CHRISTOPHER J. SANDERS
Forest Research Laboratory, Canada Department of Fisheries and Forestry, Sault Ste. Marie, Ontario

Abstract. Breeding populations of birds in the spruce-fir forests of northwestern Ontario during the current low population density of the eastern spruce budworm (*Choristoneura fumiferana*) averaged 123 pairs/100 acres compared to 319 recorded by Kendeigh (1947) in the same area during a budworm outbreak. The difference may be attributed to the virtual absence of four species of Parulidae which are known to respond numerically to increases in budworm density.

Introduction

The spruce-fir forests of eastern North America are periodically devastated by the eastern spruce budworm (*Choristoneura fumiferana* (Clem.)) which may defoliate thousands of acres of white spruce and balsam fir resulting in widespread tree mortality. The ecology of this insect and the factors regulating its numbers during an outbreak have been intensively studied in New Brunswick (Morris, 1963). It was found that several species of birds responded numerically to increasing spruce budworm densities (Morris *et al.*, 1958), although they did not contribute significantly to the regulation of the spruce budworm at high budworm densities (Morris *et al.*, 1958; Mook, 1963). Flocks of vagrant species may cause appreciable mortality in declining populations (Blais and Parks, 1964), and it is possible that the role of birds in regulating budworm numbers may be more important at low budworm densities.

Ecological investigations of the budworm have also been carried out near Black Sturgeon Lake, northwestern Ontario, since the early 1940's. The spruce-fir forests in this area were devastated by the budworm in the 1940's and 1950's, but by 1958 numbers had declined to an endemic level and it became extremely difficult to locate larvae by conventional sampling methods (Fye, 1963). Censuses were carried out in this area in 1966, 1967, and 1968 to determine the status of the population of breeding birds during the endemic phase of the spruce budworm population cycle. During the outbreak, a census was made by Kendeigh (1947) and the censuses reported in the present paper, therefore, make a useful comparison with the earlier survey, in addition to serving as background for future studies concerned with the role of birds in the regulation of spruce budworm numbers during the endemic phase of population fluctuations.

Methods

Censuses were carried out in two plots for 3 consecutive years, 1966, 1967, and 1968, from a field station on Black Sturgeon Lake operated by Canada Department of Fisheries and Forestry. Ideally, these censuses should have been conducted in the same areas as those used by Kendeigh. Unfortunately, these are now relatively inaccessible, and furthermore, the area was burned in 1953, destroying the original stands. Instead, two new locations that were easily accessible from existing bush roads and that lay well within the boundaries of extensive homogeneous stands were chosen from aerial photographs. Plot 1 was in an overmature stand with a broken canopy about 100 feet high of trembling aspen up to 24 inches dbh, as close an approximation as could be found to the stands described by Kendeigh (1947). There was a scattered understorey of white birch, balsam fir, and white spruce, and dense thickets of balsam fir regeneration and mountain maple. The total basal area of trees 3 inches dbh and larger was 92 square feet/acre, of which 53% was white birch, 23% balsam fir, 21% trembling aspen and the remainder white and black spruce. In contrast, Plot 2 was in an immature stand, typical of much of the spruce-fir forest type of the area originating after extensive mortality caused by the spruce budworm in the 1940's and 1950's. Trees ranged in size up to 6 inches dbh and 30 feet high. There were frequent small openings dominated by shrubs. The

basal area of trees 3 inches dbh and larger was 56 square feet/acre, of which 45% was balsam fir, 27% trembling aspen, and the remainder white spruce, black spruce, and jack pine in approximately equal parts.

Each plot measured 16 by 16 chains (25.6 acres). Trails were cut through the plots at 2-chain intervals, and stakes were placed along these every 2 chains. The censuses were conducted by mapping the location of singing males in the manner described by Kendeigh (1947). Between three and five censuses were made each year between 10 June and 30 June. Most of these were between 0630 and 0930 EST, but some were begun as early as 0430. None continued beyond 1000. All were conducted on calm, sunny mornings. The plots were also visited in the evenings at least once each year.

Results

The numbers of singing males recorded each year are shown in Table 1. A value of ½ has been assigned in those instances where the apparent territory of the male was partly inside and partly outside the plot. It was assumed that each singing male indicated the presence of a breeding pair. The total number of breeding pairs in the two plots remained virtually constant from year to year. In Plot 1, the counts were 28, 29½ and 29 in 1966, 1967, and 1968, respectively, an average of 115 pairs/100 acres/year. In Plot 2, the corresponding figures were 32½, 32½, and 33½, an average of 131 pairs/100 acres. The Parulidae was the dominant family in both plots, constituting 45% of the pairs in Plot 1 and 44% in Plot 2. The commonest species in the overmature stand, Plot 1, were Ovenbird, Canada Warbler, Black-throated Green Warbler, and Red-eyed Vireo, all with two or more pairs in the plot each year; and in the immature stand, Plot 2, the commonest were Magnolia Warbler, Ovenbird, and White-throated Sparrow, all with three or four pairs each year.

Three species were present in the breeding season that were not recorded in the area by either Snyder (1928) or Kendeigh (1947). These were a male Black-throated Blue Warbler heard in the same location on several occasions in 1966, a male Parula Warbler heard on three occasions in the same locality in 1967, and several Scarlet Tanagers, as many as three being heard at the same time, in 1966 and 1967.

Discussion

The relative constancy in the total number of breeding pairs and in the species composition in each plot from year to year suggests that the average figure of 115 pairs/100 acres in the overmature stand (Plot 1) and 131 pairs/100 acres for the immature stand (Plot 2) are reliable estimates of the normal breeding populations in these forest types under the prevailing conditions.

The total numbers of breeding pairs are not greatly different between the two plots, and the different families are almost equally represented. However, there are differences at the species level that can be attributed to differences in stand structure. Black-throated Green Warblers, Tree Creepers, and Purple Finches occurred regularly in the more mature stand; whereas other crown feeders, such as the Bay-breasted and Blackburnian Warblers, were present in the same stand type adjacent to the plot. All of these species were absent from the younger stands, where the dominant species, such as the Nashville and Magnolia Warblers, the *Empidonax* fly-catchers and White-throated Sparrow frequent the lower crown or thickets.

The average breeding population for the two plots over the 3 years of 123 pairs/100 acres is low compared with surveys in similar stand types in North America. Cheshire (1954) recorded populations ranging between 168 and 210 pairs/100 acres at Green River, New Brunswick, prior to a budworm outbreak. Cadbury and Cruikshank (1942) recorded a population of 242 pairs/100 acres over a 7-year period on Hog Island, Maine, although Kendeigh (1947) considered this an unusually high figure attributable to a high proportion of semi-open areas in the census plot.

Censuses conducted during budworm outbreaks show considerable increases in breeding populations over these figures. At Green River

the maximum density recorded was 333 pairs/100 acres (Cheshire, 1954), whereas Hensley and Cope (1951) recorded approximately 425 pairs/100 acres in northern Maine. At Black Sturgeon Lake, Kendeigh (1947) recorded an average of 319 pairs/100 acres. These increases occurred almost exclusively among the Parulidae, specifically Bay-breasted, Cape May, and Tennessee Warblers at Black Sturgeon Lake (Kendeigh, 1947), and Bay-breasted, Tennessee, and Blackburnian Warblers at Green River (Morris *et al.*, 1958). MacArthur (1958) concluded that the Cape May and, to a lesser extent, the Bay-breasted are opportunist species adapted by large egg clutch size to rapid increases in times of superabundant food, such as outbreaks of the spruce budworm. Between outbreaks they suffer severe reduction in numbers and possible local extirpation. It is of interest, therefore, to note that the Cape May Warbler, one of the commonest species during the peak of the outbreak in northwestern Ontario in

TABLE 1. — Numbers of singing males recorded each year.

	Plot 1			Plot 2		
	1966	1967	1968	1966	1967	1968
ACCIPTRIDAE						
Broad-winged Hawk (*Buteo platypterus*)	½	½	½	½	½	0
TETRAONIDAE						
Ruffed Grouse (*Bonasa umbellus*)	0	½	½	½	0	1
PICIDAE						
Flicker (*Colaptes auratus*)	1	1	1	1	1	1
Pileated Woodpecker (*Dryocopus pileatus*)	0	½	0	0	½	0
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	1	1	1	1	1	1
Hairy Woodpecker (*Dendrocopus villosus*)	½	½	1	½	½	1
TYRANNIDAE						
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	0	0	1	2	2	2
Least Flycatcher (*Empidonax minimus*)	1	1	2	3	2	2
Wood Peewee (*Conotopus virens*)	0	1	1	0	0	0
Olive-sided Flycatcher (*Nuttallornis borealis*)	0	0	a	0	0	0
CORVIDAE						
Canada Jay (*Perisoreus canadensis*)	½	½	½	½	½	½
Blue Jay (*Cyanocitta cristata*)	½	½	½	½	½	½
PARIDAE						
Black-capped Chickadee (*Parus atricapillus*)	0	0	0	0	1	½
Boreal Chickadee (*Parus hudsonicus*)	0	0	0	0	0	1
SITTIDAE						
Red-breasted Nuthatch (*Sitta canadensis*)	½	½	½	0	0	½
CERTHIIDAE						
Brown Creeper (*Certhia familiaris*)	1	1	½	0	0	0
TROGLODYTIDAE						
Winter Wren (*Troglodytes troglodytes*)	1	1	1	½	1	½
TURDIDAE						
Robin (*Turdus migratorius*)	0	0	0	0	1	½
Hermit Thrush (*Hylocichla guttata*)	a	½	a	a	a	½
Swainson's Thrush (*Hylocichla ustulata*)	1	1	1	1	½	½
Veery (*Hylocichla fuscescens*)	0	0	0	a	0	0
SYLVIIDAE						
Golden-crowned Kinglet (*Regulus satrapa*)	1	1	0	1	1	1
Ruby-crowned Kinglet (*Regulus calendula*)	0	½	0	1	1½	0
VIREONIDAE						
Red-eyed Vireo (*Vireo olivaceus*)	2	2	2	1	½	1
PARULIDAE						
Black and White Warbler (*Mniotilta varia*)	2	1	1½	2	2	1
Tennessee Warbler (*Vermivora peregrina*)	0	a	0	0	0	0
Nashville Warbler (*Vermivora ruficapilla*)	1	a	½	2½	2½	3½

TABLE 1. (continued)

	Plot 1			Plot 2		
	1966	1967	1968	1966	1967	1968
PARULIDAE (continued)						
Parula Warbler (*Parula americana*)	0	½	0	0	0	0
Magnolia Warbler (*Dendroica magnolia*)	2½	1	2	4	4	3½
Black-throated Blue Warbler (*Dendroica caerulescens*)	a	0	0	0	0	0
Myrtle Warbler (*Dendroica coronata*)	0	t	0	1½	1	0
Black-throated Green Warbler (*Dendroica virens*)	2	2	2½	0	0	0
Blackburnian Warbler (*Dendroica fusca*)	a	0	0	0	0	0
Chestnut-sided Warbler (*Dendroica pensylvanica*)	½	½	½	1½	1	1
Bay-breasted Warbler (*Dendroica castanea*)	0	½	0	0	0	0
Ovenbird (*Seiurus aurocapillus*)	2½	3	3½	2	3	4
Mourning Warbler (*Oporornis philadelphia*)	½	½	½	½	½	½
Canada Warbler (*Wilsonia canadensis*)	3½	2	2	t	0	0
THRAUPIDAE						
Scarlet Tanager (*Piranga olivacea*)	a	½	0	0	t	0
FRINGILLIDAE						
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	a	a	0	0	a	0
Evening Grosbeak (*Hesperiphona vespertina*)	t	t	t	t	t	0
Purple Finch (*Carpodacus purpureus*)	1	1	1	½	½	½
Pine Siskin (*Spinus pinus*)	0	0	0	0	0	t
Slate-colored Junco (*Junco hyemalis*)	0	t	0	0	0	0
White-throated Sparrow (*Zonotrichia albicollis*)	1	2½	1	4	4	4½

½ Indicates a singing male with a territory either considerably larger than the plot or with a territory lying approximately half inside and half outside the plot.
t (transient) Indicates a male singing occasionally, but not consistantly, inside the plot.
a (adjacent) Indicates the presence of a species not recorded inside the plot, but which was apparently breeding in the same forest type adjacent to the plot.

1945 (Kendeigh, 1947) was recorded in the vicinity of Lake Nipigon only once in 1927 (Snyder, 1928) and none was seen in the 3 years of the present study, not even during migration.

If the populations of these four species, Bay-breasted, Cape May, Tennessee, and Blackburnian Warblers, are subtracted from Kendeigh's figures, then his average population estimate is reduced to 134 pairs/100 acres which is close to the estimate of 124 in the present study. Possibly a part of the reduction in the numbers of these four species is owing to changes is the forest stand structure in the intervening 20 years, especially the reduction in mature spruce and fir, but much of it can be presumed to be due to the virtual absence of the spruce budworm in the area.

Summary

Censuses of singing males were conducted in an overmature and an immature stand in spruce-fir forests near Black Sturgeon Lake, northwestern Ontario, during 1966, 1967, and 1968. Breeding populations were slightly higher in the immature stands (131 pairs/100 acres) than in the overmature (115 pairs). The difference between these figures and those recorded by Kendeigh (1947) during a spruce budworm outbreak in the same area is almost entirely attributable to the absence of the Bay-breasted, Cape May, Black-burnian, and Tennessee Warblers, species which are known to respond numerically to increasing density of the spruce budworm. Their absence is attributed to the present scarcity of spruce budworm in the area.

References

Blais, J. R. and **Parks, G. H.** 1964. Interaction of evening grosbeak *Hesperiphona vespertina* and spruce budworm (*Choristoneura fumiferana* (Clem.)) in a localized outbreak treated with DDT in Quebec. Canadian Journal of Zoology 42: 1017-1024.

Cadbury, J. and **Cruikshank, A. D.** 1942. Breeding-bird census, climax red and white spruce forest. Audubon Magazine, Section 2 (142): 32.

Cheshire, W. P. 1954. Bird populations and potential predation of the spruce budworm. Canada Department of Agriculture, Annual Technical Report, Green River Project 1953, Section 14.

Fye, R. E. 1963. The status of the spruce budworm in the Black Sturgeon Lake region of Ontario. Canada Department of Forestry, Bi-monthly Progress Report 19: 2-3.

Hensley, M. M. and **Cope, J. B.** 1951. Further data on the removal and repopulation of the breeding birds in a spruce-fir forest community. Auk 68: 483-493.

Kendeigh, S. C. 1947. Bird population studies in the coniferous forest biome during a spruce budworm outbreak. Ontario Department Lands and Forests, Division of Research, Biological Bulletin 1: 1-100.

MacArthur, R. H. 1958. Population ecology of some warblers of northeastern coniferous forests. Ecology 39: 599-619.

Mook, L. J. 1963. Birds and the spruce budworm. In Morris, R. F. (Ed.) The dynamics of epidemic spruce budworm populations. Memoirs of the Entomological Society of Canada 31: 268-271.

Morris, R. F. (Ed.) 1963. The dynamics of epidemic spruce budworm populations. Memoirs of the Entomological Society of Canada 31.

————, **Cheshire, W. F.**, **Miller, C. A.** and **Mott, D. G.** 1958. The numerical response of avian and mammalian predators during a gradation of the spruce budworm. Ecology 39: 487-494.

Snyder, L. L. 1928. The summer birds of Lake Nipigon. Transactions of Royal Canadian Institute 16: 251-277.

Received August 5, 1969
Accepted February 15, 1970.

The Distribution of *Pellaea* in Canada

S. Jane Rigby and Donald M. Britton

Department of Botany, University of Guelph, Guelph, Ontario

Abstract. A survey was made of the Canadian distribution of *Pellaea atropurpurea* and *P. glabella,* the only two species of this genus of rock-inhabiting ferns which are known to be native to this country. *P. atropurpurea,* an apogamous triploid, although comparatively rare in Canada, is widely distributed, ranging from Quebec to British Columbia with its most northerly station at Lake Athabaska. Three varieties of *P. glabella* are found in Canada: var. *glabella,* an apogamous tetraploid, in Quebec and Ontario; var. *occidentalis,* a sexual diploid, in Manitoba, Saskatchewan, Alberta and the southern part of Mackenzie District; and the apogamous triploid var. *simplex* in Alberta and British Columbia. There is little overlap in the ranges of these three varieties but all three fall within the range of *P. atropurpurea.*

Pellaea is a genus of small rock-inhabiting ferns, commonly known as cliff brakes. A survey of the distribution of *Pellaea* in Canada was made as a part of a biosystematic study of the Canadian species of this genus (Rigby 1968). The purpose of this survey was to find in what regions of this country *Pellaea* has been collected, and to examine morphological variations between populations in different parts of the country as an aid to discovering more about the evolution of, and relationships between, the species and varieties involved. The information thus obtained can also be of use in obtaining experimental material from the field for further biosystematic studies.

Although the genus *Pellaea* is represented in Canada, on the basis of its worldwide distribution it could be considered more typically an inhabitant of the tropics and subtropics. The species included in the genus by Christensen (1905) are found in Asia, Africa, Oceania and North and South America, generally in tropical or subtropical regions. Tryon (1957), in reporting the distribution of the 15 species in North and South America which comprise section PELLAEA of the genus, noted that the greatest convergence of ranges was in the southwestern United States and adjacent Mexico. The only two of the species recognized by Tryon that have been found in Canada are *P. atropurpurea* (L.) Link and *P. glabella* Mett. ex Kuhn, and in each case the Canadian distribution represents the northern part of a larger range, the major area of which lies within the United States. In fact both species are comparatively rare in Canada, or at the most only locally abundant — nevertheless they form a definite (and interesting) part of the native fern flora of this country.

The distribution of *Pellaea* is limited partly by climatic factors and partly by the absence in many parts of the country of a suitable substrate, since the species in question are usually found on limestone or calcareous sandstone — for example on limestone cliffs or outcrops. In Ontario about 60 per cent of the collections of *P. glabella* and all but one of *P. atropurpurea* come from the Niagara Escarpment limestone formation.

Besides sharing a preference for a calcareous substrate, the two species show many morphological similarities. Although *P. glabella* was described as a species in 1869, many taxonomists continued to regard it as identical with *P. atropurpurea* or at the most merely as a variety of that species, so that early collections of *P. glabella* were originally designated as *P. atropurpurea* and may be found under that name in older distribution lists. Over fifty years ago, both Pickett (1917) and Butters (1917) published arguments for treating *P. glabella* as a separate species and to-day this point of view seems to have wider acceptance. For example Fernald (1950), Wherry (1961) and Cronquist (1963) all treat *P. atropurpurea* and *P. glabella* as two distinct species.

The taxonomy of the Canadian Pellaeas is complex, both because of similarity in morphological and ecological characteristics and also because of the presence of apogamy and of different levels of ploidy within the group. The system of classification used by Tryon (1957)

was adopted for this survey because it appears compatible with the morphological and cytological evidence obtained from studying these ferns (Rigby 1968) but of course information gained in further studies may lead to revisions. According to this classification, *P. glabella,* besides being recognized as a species distinct from *P. atropurpurea,* is subdivided into three varieties, namely the typical var. *glabella*, var. *simplex* Butters and var. *occidentalis* (E. Nelson) Butters. Cytological studies (Manton 1950; Tryon and Britton 1958) have shown that *P. atropurpurea* is an apogamous triploid with 87 chromosomes, while within *P. glabella,* var. *glabella* and var. *simplex* are apogamous tetraploids each with 116 chromosomes and var. *occidentalis* is a sexual diploid with somatic chromosome number of 58. A sexual diploid form of var. *glabella* has been found in Missouri (Wagner *et al.* 1965) but so far has not been reported from Canada. This diploid is morphologically very similar to the tetraploid form of var. *glabella* and comparison of their spores with respect to size and to number per sporangium is necessary to separate the two cytotypes.

The synonomy for *P. atropurpurea* and *P. glabella* is given by Tryon (1957). While Cody (1963) published a new combination for *P. glabella* var. *occidentalis,* namely *Pellaea glabella* Mett. ex. Kuhn var. *nana* (Richardson) Cody, the classification adopted by Tryon (1957) has been used here for the sake of continuity, since the distributions in this survey represent a revision of those which she reported at that time.

Some of the characteristics which can be used to distinguish between the species and varieties of *Pellaea* found in Canada are listed in Table 1. Because many of the differences between these taxa (especially those between the varieties of *P. glabella*) are quantitative rather than qualitative, and because there is considerable variation within each taxon and overlap between taxa, the identification of individual specimens has sometimes differed with the various taxonomists who have examined them. The taxa to which they have been assigned for the purposes of the present study are those to which they appear most suited on the basis of careful morphological examination by the authors.

P. atropurpurea and *P. glabella* are listed in a number of provincial and regional floras and distribution surveys. For Alberta, Moss (1959) gives *P. atropurpurea* (L.) Link var. *bushii* Mack. (with *P. glabella* Mett. as a synonym and including *P. occidentalis* (E. Nels.) Rydb.) as present in the province but does not give any within-province distribution. Taylor (1963) lists both *P. atropurpurea* and *P. glabella* var. *simplex* as being present in British Columbia and includes maps of their distribution. Scoggan (1957) gives the only *Pellaea* for Manitoba as: *Pellaea glabella* Mett. (*P. atropurpurea* (L.) Link var. *bushii* Mack.), which might be interpreted as referring to the typical variety. However, only var. *occidentalis* was found from Manitoba during the present survey, although var. *glabella* has been collected at Kakagi Lake in Ontario, less than 100 miles east of the Manitoba border. Soper (1963) presents maps of the distributions of *P. atropurpurea* and *P. glabella* var. *glabella* in Ontario, and Britton *et al.* (1967) give the distribution of these taxa in Quebec.

During the present study, in order to bring up-to-date the records of the distribution of the genus in Canada, Canadian collections of *Pellaea* were examined in or borrowed from the following herbaria (initials according to Lanjouw and Stafleu (1964, 1966)): ALTA, CAN, DAO, GH, HAM, MT, MTJB, MTMG, OAC, QFS, QK, SASK, SHER, TRT, UBC, ULF, UWO, WIN, and WIS.

The authors also visited various limestone regions in Ontario in an attempt to discover further stations of this genus and to examine the state of the previously reported colonies. The spores of collections of *P. glabella* var. *glabella* were examined, to determine whether any of the 64-spored sexual diploids were present in Canada. However all the specimens checked showed only up to 32 large, irregular spores per sporangium, and were therefore classed as apogamous tetraploids.

TABLE 1 Morphological comparison of *Pellaea atropurpurea* and *Pellaea glabella*.

Characteristic	*P. atropurpurea*	*P. glabella* var. *glabella*	*P. glabella* var. *simplex*	*P. glabella* var. *occidentalis*
Frond length[1]	6 to 50 cm	4 to 36 cm	1 to 20 cm	1 to 15 cm
No. of pinna segments[1]	up to 15	up to 7	up to 5	1 (may be 2 or 3 lobed)
Colour of stipe and rachis	dark purple to almost black	reddish brown to dark brown	reddish brown to dark brown	golden brown to dark brown
Pubescence of stipe and rachis	strong to moderate	sparce to none	sparse to none	sparse to none
Margins of fertile pinnae	slightly reflexed	strongly reflexed	strongly reflexed	strongly reflexed
Growth habit	erect	lax	lax	lax
No. of spores per sporangium	32	32[2]	32	64
Appearence of perispore	rugae prominent	rugae not prominent	rugae not prominent	rugae not prominent
Angle of pinna stalk with rachis	broad	acute	acute	pinnae almost sessile

[1]Tryon (1957).
[2]This applies to the apogamous tetraploid material found in Canada. The sexual diploid from Missouri has 64 spores per sporangium.

As a result of this survey the distributions shown in Figures 1 and 2 were plotted. A partial list of the collections used in plotting these distributions is given below. In many cases several specimens have been collected at various times from a single site — for example, from 1878 until the present time, at least 12 collections of *P. glabella* var. *glabella* have been made by various collectors at Elora, Ontario. In other cases the location given on the herbarium label was too vague to be of use. In order to present as concise a picture as possible, only the specimens bearing the earliest and latest dates from each clearly defined location are listed here.

P. atropurpurea.

ALBERTA. A number of collections made in the Banff area prior to 1917 were originally designated as *P. atropurpurea*. They have since been revised to *P. glabella*, with the exception of the following specimen, which has been confirmed as *P. atropurpurea*: Banff, Tunnel Mountain: *Sanson 85546* in 1900 (CAN).

BRITISH COLUMBIA. Columbia Lake (south end), 8 mi. S. of Canal Flats: *Taylor & Ferguson 655* in 1958 (DAO). Columbia Lake (east shore): *Taylor & Ferguson 3932* in 1958 (DAO). Fairmount Hotsprings: *Eastham* in 1942 (UBC); *Taylor* in 1951 (UBC). Kinbasket Mountain: *Eastham* in 1947 (UBC); *Calder & Savile 11976* in 1953 (DAO, MTJB, UBC).

ONTARIO. Bruce Co.: N. of Dyer Bay: *Stebbins & Loveless 1* in 1933 (GH, TRT). Gillies Lake outlet: *Taylor & Krotkov 6130* in 1933 (GH); *Britton 1062* in 1966 (OAC). 0.4 mi. N. of St. Edmunds Twp. Line, Highway 6: *Soper* in 1955 (TRT); *Britton* in 1966 (OAC). Leeds Co.: Dean Island, White Fish Lake:

FIGURE 1. The distribution of *Pellaea atropurpurea* in Canada.

Vander Kloet 6826 in 1968 (QK). Lincoln Co.: Balls Falls: *Britton* in 1967 (OAC). Near Beamsville: *Snure* in 1934 (HAM) (personal communication from the collector to D. M. Britton places the location probably near Balls Falls). Manitoulin Dist.: 1 mi. from Carnarvon-Campbell Twp. Line: *Williamson* in 1962 (TRT). High Hill: *Soper & Cook 9301* in 1961 (TRT, UWO); *Britton & Rigby* in 1966 (OAC). Robinson Twp., N.W. of Silver Lake: *Soper & Heidenreich 8907* in 1959 (DAO, QK, TRT, UWO); *Britton* in 1966 (OAC). Windfall Lake: *Britton & Rigby* in 1966 (OAC). Welland Co.: Niagara Whirlpool: *Lawson* in 1857 (CAN).

QUEBEC. Montmorency Co.: Cap Tourmente: *Rousseau & Lafond* in 1943 (MT); *Cinq-Mars, Vézina & Gravel 68-27* in 1968 (OAC). Petit Cap: *Rousseau* in 1940 (ULF). Pontiac Co.: Campbell's Bay: *Monette* in 1950 (DAO, MTJB).

SASKATCHEWAN. Cornwall Bay, near Lake Athabaska: *Raup 6558* in 1935 (CAN, GH). This collection was identified by Raup as *P. glabella* Mett. ex Kuhn. The specimen in the Gray Herbarium has been revised by Tryon, in an annotation dated 1955, to *P. atropurpurea* (L.) Link. This revision appears justified on morphological grounds, with such characteristics as size of fronds, amount of division of pinnae, angle of departure of pinna stalks from rachis and spore morphology being taken into consideration.

***P. glabella* var. *glabella*.**

ONTARIO. Algoma Dist.: Batchawana Falls: *Taylor, Hosie, Fitzpatrick, Losee & Leslie 115* in 1935 (CAN, GH, TRT). Garden River: *Fassett 14752* in 1932 (GH, WIS). Bruce Co.: Barrow Bay: *Krotkov 9594* in 1934 (DAO, GH, TRT); *Cody & Sherk 12392* in 1962 (DAO). Cape Crocker: *Scoggan 14695* in 1960 (CAN). Colpoy Bay: *Macoun* in 1871 (MT); *Krotkov 10021* in 1935 (DAO, TRT). Devil's Pulpit: *Britton 1162* in 1967 (OAC). Dyer Bay: *Krotkov* in 1936 (TRT). East Linton: *Brown* in 1942 (TRT). Flower Pot Island: *Krotkov* in 1933 (TRT). Gillies Lake: *Taylor* in 1933 (TRT); *Britton 1158* in 1967 (OAC). Hope Bay: *Krotkov* in 1935 (TRT); *Krug* in 1962 (TRT). Lion's Head: *Krotkov* in 1935 (TRT); *Britton 1156* in 1967 (OAC). Smokey Head: *Breed, Jenkins, Phillips & Stauffer* in 1933 (GH). Whippoorwill Bay: *Krotkov* in 1935 (TRT); *Britton 1064* in 1966 (OAC). Wiarton: *Saunders* in 1899 (UWO); *Britton & Rigby* in 1966 (sight record). Dufferin Co.: Mono Rocks: *Taylor* in 1933 (TRT). ½ mi.

FIGURE 2. The distribution of *Pellaea glabella* in Canada. Var. *glabella* = open circles, var. *occidentalis* = circle with dot in centre, var. *simplex* = solid black circles.

N. of Mono Centre: *Britton 1170* in 1967 (OAC). Frontenac Co.: Bon Echo Cliff: *Beschel, Dewdney & Scoggan 15946* in 1967 (QK). Grey Co.: Beaver Valley, E. of Kimberly: *Grevatt* in 1957 (TRT); *Britton 1092* in 1966 (OAC). Bowles Gully: *Grevatt & Jackson* in 1957 (TRT). Eugenia Falls: *Taylor* in 1932 (TRT). Hayward Falls: *Cody & Sherk 12433* in 1962 (DAO). Kemble: *Britton & Dale* in 1962 (OAC). Meaford: *Thompson* in 1936 (DAO, TRT); *Montgomery & Beamer* in 1950 (OAC). Mitchell's Rocks: *Soper, Rao, Grevatt & Mayall* in 1957 (MT, MTMG, TRT); *Britton 1093* in 1966 (OAC). Owen Sound: *Macoun 28.385* in 1871 (CAN); *Hand* in 1938 (DAO). Skinner's Bluff: *Britton* in 1964 (OAC); *Britton & Taylor* in 1967 (OAC). Halton Co.: Crawford Lake: *Gaiser* in 1946 (HAM); *Britton & Rigby* in 1969 (sight record). 2 mi. N.W. of Glen Williams: *Britton & Rigby 1086* in 1966 (OAC). Loweville: *Brown* in 1935 (TRT). Milton: *Brown* in 1929 (TRT); *Hillsdon* in 1954 (TRT). Mount Nemo: *McCallum* in 1942 (TRT); *Britton & Rigby* in 1969 (sight record). Rattlesnake Point: *Brown 4733* in 1935 (CAN, MTMG); *Britton & Rigby* in 1967 (OAC). Kenora Dist.: Kakagi Lake, Blacky Bay: *Bently 57542* in 1957 (CAN, MTMG). Leeds Co.: Jones Creek, 7 mi. S.W. of Brockville: *Dore & Gillett 15774* in 1955 (DAO); *Britton* in 1966 (OAC). Lake Opinicon: *Bonwill 1124* in 1960 (QK). Lincoln Co.: Grimsby: *Haines 72* in 1943 (DAO, HAM); *Britton & Rigby 1119* in 1967 (OAC). 30 mi. W. of Niagara Falls: *Scoggan 14050* in 1960 (CAN). Park Road, ½ mi. S. of Highway 8: *Maycock & Maryniak 6899* in 1958 (DAO, MTMG). Queenston Heights: *Scott* in 1896 (TRT). Rockway Falls: *McCalla* in 1897 (CAN); *Britton 1108* in 1966 (OAC). 4 mi. S.W. of St. David: *Miller 253* in 1952 (HAM). Manitoulin Dist.: 2 mi. N.E. of Evansville: *Soper & Heidenreich* in 1962 (TRT). Gore Bay: *Pease & Ogden 25015* in 1935 (GH); *Soper & Heidenreich 8972* in 1959 (QK, TRT). 1 mi. S. of Green Bay: *Soper & Warren 10439* in 1963 (DAO, TRT). High Hill: *Jenkins & Dalton 7734* in 1957 (DAO); *Britton & Rigby* in 1966 (OAC). Ice Lake: *Soper & Heidenreich* in 1962 (TRT). West Bay: *Brown* in 1937 (TRT); *Cody, Dore, Soper & Montgomery 9451* in 1956 (DAO). Nippising Dist.: Talon Chute, Mattawa River: *Miller 1723* in 1964 (DAO). Peel Co.: Credit Forks: *White 28388* in 1889 (CAN); *Britton & Britton 1095* in 1966 (OAC). Simcoe Co.: Singhampton: *Cain* in 1930 (TRT); *Brown* in 1937 (TRT). Thunder Bay Dist.: Bat Cave, Cavern

Lake: *Garton 5790* in 1958 (DAO, MT). Thunder Cape: *Taylor, Losee & Bannan 41* in 1936 (CAN, GH, TRT). Waterloo Co.: Galt: *Herriot* in 1892 (OAC); *Britton* in 1966 (OAC). Welland Co.: Foster's Flats (Niagara Glen): *Scott* in 1895 (TRT); *Britton* in 1967 (OAC). River Road (between Niagara Falls and Queenston): *Soper & McCallum 2278* in 1940 (GH). Wellington Co.: Elora: *McPherson* in 1878 (MTMG); *Britton* in 1967 (OAC). Eramosa Twp. V, VI: *Britton 1480* in 1968 (OAC). Everton: *Montgomery* in 1946 (OAC). Rockwood: *Lowe* in 1927 (WIN); *Britton* in 1967 (OAC). Wentworth Co.: Near Aldershot: *Knapp 4* in 1943 (HAM). Borers Falls: *Britton 1500* in 1969 (OAC). Dundas Ravine: *Burgess* in 1888 (MTMG, TRT). Hamilton (near Asylum): *Wright* in 1880 (DAO).

QUEBEC. Richmond Co.: Petit Lac Brompton: *Forest 641* in 1967 (OAC, SHER).

P. glabella* var. *occidentalis.

ALBERTA. Banff, Mount Rundle (base): *Ogilvie* in 1967 (OAC). Banff, Sawback Range: *Pelluet 91777* in 1915 (ALTA, CAN). Banff, Tunnel Mountain (cliffs): *McCalla* in 1899 (ALTA). Banff, Tunnel Mountain (north slope): *Sanson 22281* in 1899 (CAN). Rocky Mt. Park, Tunnel Mountain (south end): *Smith 28386* in 1889 (CAN).

MANITOBA. Athapapuskow Lake: *Hudson 1585* in 1954 (DAO). Grand Rapids: *Scoggan 5077* in 1948 (ALTA, CAN, MTMG, WIN). 14 mi. N. of The Pas: *Bird* in 1953 (WIN). Stony Mountain: *Lowe* in 1939 (WIN).

NORTHWEST TERRITORIES (DISTRICT OF MACKENZIE). Cli Lake, Nahanni Range: *Cody & Spicer 12242* in 1961 (DAO, SASK). Franklin Mountains at River-Between-Two-Mountains: *Crickmay 9* in 1945 (CAN).

SASKATCHEWAN. Carswell (Trout) Lake: *Argus 482-62* in 1962 (DAO, SASK). Clearwater River, 57° N.: *Macoun 28389* in 1887 (CAN). Deschambault Lake, Ballantyne Bay: *Argus 4252* in 1964 (DAO, SASK). Coulée Hudson à Big Muddy: *Boivin, Löve & Dunbar 10305* in 1954 (ALTA, DAO, MTMG, SASK, WIN). Meridian Creek Tower: *Hudson 1236* in 1953 (DAO). Roche Percée, Coulée Souris: *Boivin & Perron 11820* in 1958 (DAO, SASK).

P. glabella* var. *simplex.

ALBERTA. 18 mi. N.W. of Calgary: *McCalla 11403* in 1951 (ALTA). 12.5 mi. N.W. of Calgary: *Ogilvie* in 1967 (OAC). Cochrane: *Campbell* in 1940 (DAO). Jasper, DeSmet Range: *Calder 23920* in 1959 (DAO). Jasper, Fitzhugh: *Macoun* in 1919 (CAN).

BRITISH COLUMBIA. Alexis Creek: *Newcome 107* in 1915 (UBC). 7½ mi. S. of Alkali Lake: *Calder, Parmelee & Taylor 17102* in 1956 (DAO, UBC). 15 mi. N.W. of Ashcroft: *Calder, Parmelee & Taylor 16578* in 1956 (DAO, MTJB, UBC). Columbia Lake: *Murray* in 1938 (DAO, UBC). Fraser River, between Williams Lake and Riske Creek: *Calder, Parmelee & Taylor 18008* in 1956 (DAO). Fort St. James, Mount Pope: *Calder, Savile & Ferguson 13576* in 1954 (DAO). 12 mi. N. of Jesmond: *Calder, Parmelee & Taylor 16633* in 1956 (DAO). Between Nicola and Kamloops: *Dawson 28390* in 1877 (CAN). Pavilion Lake, Marble Canyon: *Taylor 1293* in 1954 (UBC). 12 mi. from Pavilion: *Calder & Spicer 33384* in 1962 (DAO). Rattlesnake Flat, near Ashcroft: *Hill* (DAO). Sword Creek, between Williams Lake and Riske Creek: *Calder, Parmelee & Taylor 17978* in 1956 (DAO, UBC). Summerland: *Wilson 1087* (UBC). Yellowhead Pass: *Marlborough 21098* in 1893 (CAN).

While the above list gives an indication of the distributions of *P. atropurpurea* and *P. glabella* in Canada, it also reflects to some degree the distribution of collectors. For example, the large number of collections made in southern Ontario is probably partly due to the fact that many of the colonies in that area are easily accessible to both amateur and professional botanists, so that a collecting trip may involve no more than an afternoon's outing. (The high density of human population in southern Ontario may also be affecting the distributions of

Pellaea directly by the disruption of suitable habitats through quarrying and other types of development.) However, even when these facts are taken into consideration, it can be seen that *P. glabella* var. *glabella* is comparatively common along the Niagara Escarpment, from Niagara Falls to Manitoulin Island. It is also found in other limestone regions of Ontario, but has been collected at only one location outside that province, namely in southern Quebec.

P. glabella var. *occidentalis* is found from Manitoba to Alberta and as far north as the southwestern part of the District of Mackenzie, while *P. glabella* var. *simplex* has been collected in Alberta and British Columbia. Thus, the ranges of the three varieties of *P. glabella* found in Canada are fairly discrete except for a region of overlap in southwestern Alberta.

P. atropurpurea appears to be rare in Canada — fewer than two dozen locations for it were plotted during the present survey. Nevertheless, its distribution overlaps that of all three varieties of *P. glabella,* from Quebec in the east to British Columbia in the west, with its most northerly station at Lake Athabaska in northern Saskatchewan.

For the country as a whole the greatest number of collections have been made in southern Ontario, while the greatest diversity of taxa is found in southwestern Alberta, where *P. atropurpurea, P. glabella* var. *occidentalis* and *P. glabella* var. *simplex* have all been collected within a hundred miles of each other.

The distributions obtained from this survey may be compared with those mapped by Tryon (1957) for North America as a whole. According to her maps, *P. atropurpurea* has almost a continent-wide distribution in the United States, although it does not extend to the west coast, while of the three varieties of *P. glabella* var. *glabella* is found in the eastern half of the country, var.*occidentalis* in the west central region and var. *simplex* in the far west. The Canadian distributions appear to follow a similar pattern, with the presence of *P. glabella* var. *occidentalis* in Manitoba extending the range of that variety somewhat further east than it has been found in the United States. It is interesting to note that this diploid member of the genus has been collected further north than any of the polyploids, although evidence has been presented that in the plant kingdom in general polyploids have an advantage over diploids in far northern latitudes (Löve and Löve 1949).

Further collections, especially from the less settled parts of the country, will be helpful in increasing our knowledge of the distribution of these ferns in Canada. At the same time a more thorough biosystematic study of these taxa will be necessary to clarify the relationships between them and to give an indication of the evolution of the group. Such a study cannot be based on Canadian material alone, for the existence of the diploid cytotype of *P. glabella* var. *glabella* in Missouri must be taken into consideration, while other species found in the United States or farther south may have been involved in the ancestry of the Canadian Pellaeas. Some questions which need to be answered in order to present a definitive classification of these taxa concern the relationships among the varieties of *P. glabella*. Should the diploid var. *occidentalis* be given species rank, as was done by Rydberg (1900), using the name *P. pumila*? How distinctive are the differences (mostly quantitative) between the two apogamous tetraploids, var. *glabella* and var. *simplex*? Do these tetraploids have a common origin, and if so what is their relationship to the diploid form of var. *glabella* and to var. *occidentalis*? Experimental work, including hybridization studies, may lead to a better understanding about the origins and relationships of these ferns.

Acknowledgements

The authors wish to thank the curators of the herbaria listed above for permission to examine the specimens under their care. Special thanks are also due to Dr. R. T. Ogilvie of the University of Calgary, who kindly collected material in Alberta for use in this study.

Financial assistance from the National Research Council, the Ontario Graduate Fellowship Program and the Ontario Department of University Affairs is gratefully acknowledged.

Literature Cited

Britton, D. M., A. Legault and S. J. Rigby. 1967. *Pellaea atropurpurea* (L.) Link and *Pellaea glabella* Mett. in Quebec. Le Naturaliste Canadien 94: 761-763.

Butters, F. K. 1917. *Pellaea atropurpurea* (L.) Link and *Pellaea glabella* Mett. ex Kuhn. American Fern Journal 7: 77.

Christensen, C. 1905. Index filicum 1753-1905. Hafniae.

Cody, W. J. 1963. A contribution to the knowledge of the flora of southwestern Mackenzie District N.W.T. The Canadian Field-Naturalist 77: 108-123.

Fernald, M. L. 1950. Gray's manual of botany. 8th edition. American Book Co.

Gleason, H. A. and **A. Cronquist.** 1963. Manual of vascular plants of northeastern United States and adjacent Canada. D. Van Nostrand Company Inc.

Lanjouw, J. and **F. A. Stafleu.** 1964. Index herbariorum. Part I. The herbaria of the world. 5th edition. Regnum Vegetabile 31: 1-251.

————. 1966. Supplement to "The herbaria of the world." Taxon 15: 334-336.

Löve, A. and **D. Löve.** 1949. The geobotanical significance of polyploidy. I. Polyploidy and latitude. Portugaliae Acta Biologica, Series A: 273-352.

Manton, I. 1950. Problems of cytology and evolution in the Pteridophyta. Cambridge University Press.

Moss, E. H. 1959. Flora of Alberta. University of Toronto Press.

Pickett, F. L. 1917. "Is *Pellaea glabella* Mett. a distinct species?" American Fern Journal 7: 3.

Rigby, S. J. 1968. An investigation of *Pellaea glabella* Mett. ex Kuhn and *Pellaea atropurpurea* (L.) Link and their relationships. Master's thesis. University of Guelph.

Rydberg, P. A. 1900. Catalogue of the flora of Montana and the Yellowstone National Park. Memoirs of the New York Botanical Garden 1: 4.

Scoggan, H. J. 1957. Flora of Manitoba. National Museum of Canada Bulletin No. 140.

Soper, J. H. 1963. Ferns of Manitoulin Island, Ontario. American Fern Journal 53: 28-40; 71-81; 109-123.

Taylor, T. M. C. 1963. The ferns and fern-allies of British Columbia. 2nd edition. British Columbia Provincial Museum Handbook No. 12.

Tryon, A. F. 1957. A revision of the fern genus *Pellaea* section PELLAEA. Annals of the Missouri Botanical Garden 44: 125-193.

————. and **D. M. Britton.** 1958. Cytotaxonomic studies on the fern genus *Pellaea*. Evolution 12: 137-145.

Wagner, W. H. Jr., D. R. Farrar and **K. L. Chen.** 1965. A new sexual form of *Pellaea glabella* from Missouri. American Fern Journal 55: 171-178.

Wherry, E. T. 1961. The fern guide. Northeastern and midland United States and adjacent Canada. Doubleday & Co.

Received August 13, 1969
Accepted November 4, 1969

Observations on the Seasonal Behaviour of the Hudson Bay Eider *(Somateria mollissima sedentaria)*

MILTON M. R. FREEMAN

Department of Sociology and Anthropology, Memorial University of Newfoundland.

Abstract. The Hudson Bay eider occurs in large breeding and wintering concentrations among the Belcher Islands in south-eastern Hudson Bay. In the spring, soon after open water appears near to the breeding locations, eiders appear in a sudden build-up of numbers at these places. From the marked absence of courtship activities it is concluded that pairing has already taken place as a prelude to these inshore movements. The Hudson Bay race appears to produce more and larger eggs than other northern eider races; this is thought to be a consequence of the larger body size, itself the result of selective pressures operative on the wintering population. The peak of egg-laying in 1960 occurred one week after break-up of the sea-ice locally, although it had started before break-up of the sea-ice in both 1959 and 1960. There was no evidence that male eiders shared nesting duties with females, though males stayed in the vicinity of the colonies even during their post-nuptial moult in some cases. Among the inland nesting eiders, predation of eggs and young by gulls was thought to be particularly severe. The varying association of eiders with old squaw duck and black guillemot during most of the year was noted. An apparent negative association of eider with pintail, scoters and mergansers was observed. The development of the non-migratory Hudson Bay race is suggested as resulting from factors of local climate, larger body size, and decreased mortality among non-migrants in the original post-glacial colonizing population of North Atlantic eiders.

The taxonomy of the eiders is subject to varying interpretation; the geographic races overlap in distribution, and several taxonomic characters intergrade. It is generally held that the three races of eider occuring in north-eastern Canada belong to the circumpolar species *Somateria mollissima*.

The Hudson Bay eider, *Somateria mollissima sedentaria* Snyder, has a range extending from southern James Bay to northern Hudson Bay. It is not thought to occur on Southampton, Coats or Mansel Islands in the northern part of its range (Godfrey 1966: 76).

Very little is known of the biology of the Hudson Bay eider. The original description (Snyder 1941) is based largely on a comparison of study skins of the various geographic races; however, the name accorded this race, *sedentaria*, refers to the habit of over-wintering in the region of its breeding grounds. Data from the James Bay region (Manning and Coates 1952, Manning 1952, Manning and Macpherson 1952) provide information on breeding distribution, and flock composition. Population estimates and breeding distribution from the King George and Sleeper Islands are available (Manning 1946) and information of a similar nature from the east coast inshore islands of Hudson Bay (Manning 1949). Observations on breeding eiders in the Nastapoka Islands, made by O. J. Murie in 1915, have recently been published (Todd 1963: 86). A detailed study of duckling behaviour has been made (Driver 1960), centred on the Belcher Island populations.

In the northern part of Hudson Bay, where populations of both the Hudson Bay race and the northern race overlap, very little is known. Breeding records for Chesterfield Inlet are published (Savile 1951) and Manning reports them overwintering at Cape Fullerton (in Bray, 1943). According to Toma, (per. com.) a Southampton Island resident who wintered on Coats Island in 1960, no eiders were seen at the edge of the land-fast ice to the north and east of Coats Island during that winter, although they have been recorded in the region at other times (Sutton 1932).

The writer was able to make observations on the Belcher Islands, southeast Hudson Bay, where large numbers of eider breed and pass the winter. The main area of observation was in the neighbourhood of the Kasegalik River mouth, Robertson Bay, and the river drainage from this Bay five miles inland to the origin of the river from Kasegalik Lake. The periods of observation were from May 20 to August 31,

1959, and April 29 to September 28, 1960. During a further visit to the Islands (February to April 1961) certain data on winter distribution were obtained.

Acknowledgments are gratefully made to the Carnegie Arctic Program of McGill University, the Banting Fund of the Arctic Institute of North America and the Arctic Unit, Fisheries Research Board of Canada for financial and logistic support of this and other studies on the Belcher Islands.

Phenology

The maritime influence on the climate of the Belcher Islands produces more equable temperatures there than on the adjacent mainland. Meteorological data from weather stations on the mainland do not indicate conditions on the Belcher Islands, and no such data are available from the Islands themselves. Summers are generally cooler, with more overcast and windy days than on the adjacent mainland (Flaherty 1918). The usual features of spring are at least two, perhaps even more weeks later in making their appearance on the Islands. Notes were made on certain phenological features both in 1959 and 1960. Though not matched with temperature readings in 1959, they allow the conclusion to be drawn that at this low latitude, seasonal features in the spring are governed more by the strength and direction of the prevailing wind than by the regular progression of time. Thus, for example, strong northerly winds at the end of May and in early June lowered the air temperature appreciably (Table 1) and yet at the same time hastened the break-up of the sea and river ice locally (Table 2).

Pre-nesting activities

In winter eiders occur in open water principally to the west and north of the Belcher Islands where the edge of the land-fast ice occurs within a few miles of the outermost land of the archipelago; during this season onshore winds may cause eiders to seek out sheltered open water among the Islands. At several locations pools remain unfrozen within the fast-ice due to localized currents, for example, among the skerries to the south-west of Robertson Bay, at the passage between Snape Island and Flaherty Island, and by Ney Island in Kipalu Inlet.

TABLE 1. — Some climatological features. South Flaherty Is. 1960.

Mo.	Quarter	Mean Max. Temp.	Range Max. Temp.	Mean Min. Day T.	% over-cast
May	1st	35.3°	31 – 40	24.6	70
May	2nd	37.1	28 – 48		40
May	3rd	44.7	40 – 46	—	65
May	4th	52.0	48 – 55	—	20
June	1st	48.3	44 – 52	—	50
June	2nd	51.3	39 – 58	—	50
June	3rd	56.5	49 – 73	37.0	40
June	4th	60.0	52 – 76		50
July	1st	60.3	44 – 70	39.0	50

Although a non-migratory race, there are decided 'movements' in the spring which are migrations, insofar as they are a prelude to breeding activities and directed toward the nesting areas.

On May 28, 1960 open water first appeared in the tidal part of the Kasegalik River, about two miles from the breeding skerries in Robertson Bay. The following day three males and three females were observed flying over the water, whilst one male was seen on the water. During the four days before open water appeared, small numbers were seen flying in this general area. Usually these flights were of one or two pairs, but on other occasions up to ten birds were seen, exclusively or predominantly males.

Similar behaviour was noted the previous year when open water at the river mouth had appeared a few days before observation was commenced on May 22. On that date nine males and seven females were seen at the open water which extended 120 by 80 yards in the tidal part of the river. Large numbers were flying north the following day but did not settle on the open water. Although flocks of between thirty and one hundred eiders were sighted sev-

TABLE 2. — Phenological Data.
South Flaherty Island

	1959	1960
Arrival of Canada geese		April 30th
Running water on tundra		May 15th
First Canada goose egg	May 19th	May 20th
Saxifraga oppositifolia starts flowering	May 26th	
Major migration of snow and blue geese	May 28th	May 20th
Break-up of tidal part of Kasegalik River	June 12th	June 4th
Break-up of sea-ice, exposed south coast Flaherty Island	June 13th	May 28th
Eggs of semi-palmated plover laid	June 14th	June 20th
Break-up of sea-ice, sheltered bays, south coast of Flaherty Island	June 26th	June 8th
First flowering of *Dryas integrifolia*	June 21st	
Dryas generally in flower, south-facing slopes	June 29th	
Mosquitoes appear for first time	July 2nd	June 25th

eral times daily, only five pairs were seen on the river ice by the increasing area of open water on May 31. However, in the next few days an increase in numbers occurred suddenly, such that by June 3, 105 eiders were counted on the ice and on the water at the river mouth. The build-up of numbers occurred in similar fashion in 1960 at this locality.

These spring concentrations away from the open-water at the edge of the land-fast ice occurred elsewhere among the Islands, including inland locations. Thus on June 4, 1959 thirty eiders were seen on a tundra pool about four miles inland from the river mouth; on June 1, 1960 many pairs were seen in the open water below the falls from Kasegalik Lake into Kasegalik River, a similar distance inland.

No courtship displays were noted in any of these early spring groups, though males were heard calling at infrequent times; it is possible that pairing has already occurred before these movements toward breeding areas takes place. Certainly inactivity characterized the behaviour of the pairs and groups seen at the river mouth and by the falls inland.

By the second week of June, though Robertson Bay was still ice-covered, the sea-ice to the east was breaking up, and numbers of eiders appeared along the remaining land-fast ice off the south of Flaherty Island. Several females were observed to be walking with some difficulty; some of these heavy females were accompanied by two males.

Two females taken at Kasegalik River mouth on June 4, 1960 contained ova measuring 48 and 14.5 mm. respectively. By June 9 a female from the same location had a fully formed soft-shelled egg in the oviduct.

Breeding activities

The ice between the shore and the skerries in Robertson Bay broke up on June 8, 1960. Nesting was well under way when the skerries were visited on June 12. Allowing twenty-four hours between successive eggs in a clutch (Sutton 1932: 70), it would appear that egg laying commenced before the ice-bridge between the nesting sites and the shore had disapeared. This certainly occurred the previous year, as a party of hunters collected fourteen eggs from one islet whilst sledging over the still-frozen Robertson Bay on June 19, seven days before break-up of the sea-ice occurred.

From the data presented in Table 3 it is seen that egg laying started around the end of the first week in June, and was mostly finished by the first week in July (allowing a twenty-eight day incubation: e.g., Gross 1932: 394, Pedersen 1962: 62). In 1960 the peak of egg laying was reached one week after the ice broke up around the nesting sites.

No definite information was gathered on the role of the male during the nesting season. The male northern eider in Greenland is reported as remaining with the female by the nest during the initial period of incubation (Salomonsen 1950:

TABLE 3. — Clutch size, at two breeding colonies, Robertson Bay 1960.

Date	No. of nests	Number of eggs per nest							Average egg no. per nest
		1	2	3	4	5	6	7	
June 11	8	0	4	1	2	1	0	0	3.00
June 21	61	2	6	5	8	22	17	1	4.59
July 6	49	2	1	3	12	22	8	1	4.61
July 31	2	0	0	1	0	1	0	0	4.00

127). The same has been noted for northern eider on Southampton Island (Sutton 1932: 70) and Hudson Bay eider on the Nestapoka Islands (Murie, in Todd 1963: 186). However, the American eider is reported as deserting the female before the latter starts egg-laying (Gross 1938: 389).

Large numbers of both males and females were always in evidence on the sea near the breeding skerries in Robertson Bay; whether these were from breeding pairs or non-breeding individuals was not ascertained. Few males were seen on the skerries at the time of our visits, but this may have been caused by our approach.

Four males and one female were seen on the water below the falls from Kasegalik Lake on June 18, 1960. Three pairs and four individual males were seen at this location six days later. On June 25, 1960, several pairs were observed in a section of Kasegalik River abounding with likely nesting sites, though no nests were found during a brief search. It is concluded that males remain in the vicinity of the breeding females, but there is no evidence that they are greatly involved in nesting activities. The small number of weighings made through the season (Table 4) suggest the males continue normal feeding, unlike the incubating females. On July 2, 1959, males in eclipse plumage were observed near the skerries in Robertson Bay.

On July 6, 1960, a pair of eiders was seen with downy young in the tidal part of Kasegalik River. This was a unique observation: though several females might combine with their broods, no other case was observed where a male remained with a brooding female.

The last date when females were observed with ducklings was August 25, 1960. On this date a female with four young was observed in Eskimo Harbour; two days earlier two females with seven young were seen at the same location.

Nesting sites

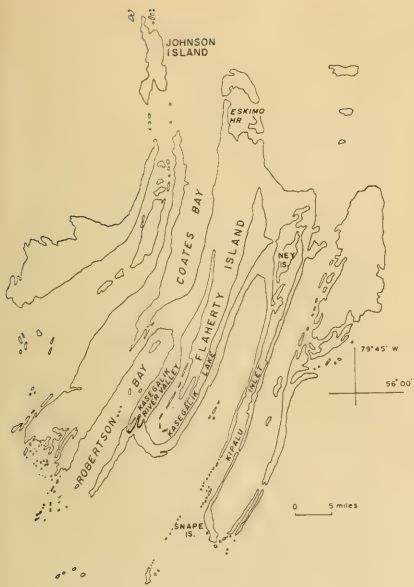
The two breeding locations examined in mid-Robertson Bay were approximately 4000 and 1000 square yards in area. Low lying and exposed, they supported an average of one nest per eighty square yards, at the height of the nesting period. However, due to the apparent need for vegetation as the basis for a nest location, and the presence of extensive barren rocky shores and outcrops, the nests occupied the suitable regions at a far higher density: ten nests per twenty-five square yards was not unusual.

The vegetation was dominated by two species. The beach grass, *Elymus arenarius*, predominated over most of the islets; it occurred in clumps around the shores, and formed a continuous mat over the central part of the larger islet. *Saxifraga caespitosa*, was the only other prominent component of the vegetation. It occurred abundantly in moist depressions on the bedrock.

The beach consisted of rough gravel, a large proportion of which was derived from the pale grey siliceous dolomitic substrate. There was one prominent ridge on the larger of the two islets, attaining a maximum elevation of between

TABLE 4. — Weights of *S. m. sedentaria*

Date	Males (grams)	Females (grams)	Remarks
June 4th, 1960	2450 2600 2550 2725 2525	3000 3025 2575	Prior to nesting, but all paired.
June 21st, 1960		2275	Incubating.
July 7th, 1960	*2425 2275 2225	1575 1825	*Immature non-breeding.
Mar. 15th, 1961	2750	2325	



fifteen and twenty feet. The water shelved rapidly from around the skerries, but the depth of the bay was not great. Eiders examined were feeding on *Mytilus edulis* and *Macoma baltica,* both shallow water molluscs in this region. The nests were composed almost entirely of down, and the small amount of foreign material present was probably accidental. Nests were usually situated in a clump of *Elymus*. One atypical, downless nest was seen, with the eggs retained in the form created by earlier nests among the stem bases of the grass. The eggs measured 84 × 47; 85 × 50; 86 × 49 mm. being both longer and narrower than average (these particular measurements are not included in Table 5).

Females hurriedly leaving the nest did not cover the eggs with down, but frequently defaecated over the eggs. Nests with eggs covered by down were found however, so it is assumed the females periodically leave the nest during the incubation period.

The largest islet contained seven herring gull nests, two old squaw nests and forty-two eider nests at the time of its maximum occupancy.

The gulls' nests were generally on the high ground away from, or well above the water.

In addition to the two colonies in Robertson Bay a small number of nests were found inland. On June 18, 1960 a well-concealed nest with six eggs was discovered on a richly vegetated hillside in a small gorge by the falls from Kasegalik Lake. Four nests were found on June 23, containing 3, 3, 1, and 0 eggs; these nests were located on an exposed smooth rock islet in the centre of Kasegalik River.

The difference in egg-number between the exposed and concealed nests is probably due to predation by the large number of gulls (*Larus hyperboreus* and *L. argentatus*) on the cliffs and islands in the upper Kasegalik River valley. Predation by gulls is illustrated by the following observation made in this locality later the same season:

July 21 several female eiders each with four or five downy young were seen; also three females with a creche of fourteen downies. August 2, a survey of this same region revealed three female eiders with no young, and a group of ten females with twenty-four ducklings.

The variations in egg dimensions between inland and coastal nesting eiders (Table 5) are not significantly different.

Fall distribution

Several sheltered bays and inlets are favoured by sea duck at this season of frequent storms in southern Hudson Bay. The west side of Eskimo Harbour and Coates Bay are especially favoured by large rafts of eider in the north of the Belcher Islands. In the south, the highly indented coastline to the south-west of Robertson Bay is similarly frequented by eider. Kipalu Inlet is visited by large numbers of scoters and mergansers in later summer and the fall, but eiders are not notably present.

These bays generally freeze over at the end of November, and when this occurs the eiders leave for the open water immediately to the north and west. In years of bad storms, or late

freeze-up, the eiders remain another month at these localities, according to local informants.

Population estimates

The greatest concentration of eider duck in the Belcher Islands probably occurs in the complex coast to the south-west of the mouth of Robertson Bay. During the winter months some open water remains at this location due to currents, and open water at the edge of the land-fast ice is not too far distant. The innumerable small islands provide favourable breeding sites in summer. The marine eel-grass (*Zostera marina*) at this location may also be especially favourable to sea ducks.

The region to the east of Robertson Bay however, has few eiders, except in the spring when open water appears early along the south coast of Flaherty Island. Few eiders breed in the eastern part of the islands, and open water is some distance away. However, during stormy winter weather, eiders frequent this region for short periods.

Table 6 presents a summary from census data obtained in 1959 and 1960.

Association of eiders with other species

A number of other bird species were seen in association with eiders in the study locations. Most of these species-associations are possibly without real significance, for of the forty-two species observed on the Belcher Islands (excluding accidentals) all but six are associated with the marine, littoral, or freshwater habitats where eiders are found. However, certain observations may be meaningful, more especially negative association.

In the spring eiders were seen with old squaw (*Clangula hyemalis*) at several differing habitats: the ice alongside open water in the tidal part of Kasegalik River; on the water at the same location; in the seaward edge of the land-fast ice south of Flaherty Island; in the open water beyond this ice; on the shore leads developing on freshwater lakes near the coast. Also at this season black guillemot (*Cepphus grylle*), although appearing inshore later than the two duck species, was usually also present

TABLE 5. — Variation in egg measurements (in millimetres).

	Number	Range	Mean	S.E.	Location
Length	71	75 – 89	80.8	1.174	Robertson Bay (marine)
Width	71	50 – 55	52.9	0.597	
Length	13	75 – 84	79.4	2.486	Kasegalik River (freshwater)
Width	13	50 – 55	51.8	1.461	

on the marine or brackish open water, though never on freshwater or on the ice.

At one open water pool in the sea-ice near to Snape Island, pintail (*Anas acuta*), white-winged scoter (*Melanitta deglandi*) and old squaw were generally present from the last week of May till break-up in mid-June. Eiders were not observed on this open water, or in this locality till after break-up of the sea ice. Loons (*Gaver immer* and *Gaver arctica*) were observed in courship in the Kasegalik River mouth area around the begining of June, but maintained distance from the fairly numerous eiders, old squaw, and guillemots. A part of the river, less than two hundred yards distant, was occupied by feeding mergansers (*Mergus merganser*, and *Mergus serrator*); the mergansers and loons

TABLE 6. — Population estimates.
South Flaherty Island.

Date	Location	Pop. Density	Census Area
Early June	Edge of land-fast ice; S. Flaherty Is.	30/linear mile	4 miles
Mid-June to late July	Within 2-mi. radius of breeding sites Robertson Bay.	12.5/sq. mile	16 sq. mi.
,, ,,	Kasegalik River, from mouth to origin at lake.	5/sq. mile	16 sq. mi.
,, ,,	S. Kasegalik Lake, in vicinity of likely breeding localities.	1.3/sq. mile	16 sq. mi.

were both feeding on abundant small fish (sticklebacks), which were not found in the crops or gizzards of the ducks or guillemot.

Several old squaw would be resting or feeding in close physical proximity to eiders at this season. The same was true for some individual king eider (*Somateria spectabilis*); one male was seen amongst twenty-five eiders on June 3, 1959 on the open water at Kasegalik River mouth, and on June 18 two immature male king eiders were seen at the same location in a flock of between fifty and seventy eiders.

After break-up of the sea and river ice, several more species occurred in the observation locality. Arctic terns (*Sterna paradisaea*) arrived on the day after break-up of sea-ice, and frequented shorelines of small bays where scoters occurred, but not eiders. Male American goldeneye (*Bucephala clangula*) and American mergansers were seen in close association on Kasegalik River where eiders were later seen nesting; but these two species remained in separate feeding and resting groups from the eider and old squaw. Canada geese (*Branta canadensis*), common loon and pintail nested in this same river valley close to the river, or on islands in the river, but no feeding or other behaviour was seen to occur in mixed species groups, or in proximate groups.

At the breeding skerries in Robertson Bay nests of eider, old squaw, herring gull (*Larus argentatus*) and guillemot occurred within the very limited area of the skerries. No terns nested on these skerries, and only once were they observed feeding nearby. On June 11, 1960 a small group of twelve to fourteen brant (*Branta bernicla*) were seen on the water by these nesting sites; when disturbed they flew several circuits with circling eiders, and alighted on the water with the eiders. However, these birds were not seen at a later date on the Belcher Islands, and apparently they only occur on migration.

Eiders continue their association with old squaw and guillemot during the fall and winter months, though the guillemot appear to withstand more exposed situations at these seasons than the ducks.

From the preceding observations it is evident that for much of the year eider, old squaw and guillemot associate together. This is particularly true in the winter when habitat requirements (i.e. open water) coincide. In the spring months association continues before nesting commences, but becomes less marked during the breeding season as nesting requirements are only partly coincident. The herring gull associates closely with the eider during the breeding season, and certainly inland where breeding sites are separate, the association is probably to the disadvantage of the eider (see above). On coastal skerries the peak of gull egg-laying was the end of the first week in June which is synchronous with eider laying. Droppings of gulls examined on the skerries contained only the bones of lemmings on July 6, 1960 (the date many gulls' eggs were hatching), but no definite information was obtained on possible predation by gulls on eggs or young eider at these breeding grounds (cf. Olsson, in Lack 1954: 257).

According to local informants, the king eider is a coastal nesting species in some northern parts of the Belcher Islands (e.g. Johnson Island). It is possible that these two eiders associate at the breeding season, though the evidence presented here only indicates a feeding association of the few king eiders present with the predominating eider.

Inland-nesting eiders shared breeding habitats with common loon, old squaw and Canada geese near Kasegalik Lake outflow.

There is some evidence to suggest a positive lack of association between eider and pintail, and between eider and the three species of scoter on the Belcher Islands at all seasons of their joint presence (see also, Twomey and Herrick 1942: 288).

Development of a resident eider population in Hudson Bay

The Hudson Bay eider appears to be larger than either *Somateria mollissima borealis* to the north, or *Somateria mollissima dresseri* to the east (Table 7).

The average lengths and widths of 86 eggs measured on the Belcher Islands (Table 4) are

TABLE 7. — Size variation, as indicated by wing chord (in mm.)

SPECIES	FEMALE			MALE			REFERENCE
	No.	Mean	Range	No.	Mean	Range	
S. m. sedentaria	4	281.5	274—289	8	290.6	284—303	Snyder, 1941.
S. m. sedentaria	10	285.5	273—296	—	—	—	Manning, 1949.
S. m. sedentaria	9	287.0	272—305	—	—	—	Manning and Coates, 1952.
S. m. sedentaria	1	274	—	1	297	—	Manning, 1952.
S. m. dresseri	17	270.0	262—284	15	277.8	263—292	Snyder, 1941.
S. m. borealis	6	267.0	259—278	16	273.9	256—289	Snyder, 1941.
S. m. borealis	31	267.7	251—280	25	278.0	263—296	Macpherson and McLaren, 1959.

greater than published measurements for 76 eggs of *borealis* populations and 59 eggs of *dresseri* (Bent 1925: 84, 98). The clutch-sizes (Table 3) tend to be larger in Hudson Bay, than among *dresseri* populations to the south (Gross 1938: 392; Lewis 1939: 71) and *borealis* to the north, (Salomonsen 1950: 127; Cooch 1965: 31).

The greater egg and clutch sizes may be explained by the larger body size of the Hudson Bay eider compared to the other races.

The apparent paradox of the larger *sedentaria* individuals breeding to the south of the smaller *borealis* (contrary to Bergman's Rule) is explicable by selective pressures operating during the winter, when *sedentaria* occurs to the north of *borealis* (Salomonsen 1955: 43-57).

The development of a resident geographic race of eider in Hudson Bay is not unexpected when one considers the climate of the region and the behaviour of the species. Eiders are powerful ducks, well adapted to withstand cold weather and stormy seas. Throughout their circumpolar range local populations of *Somateria mollissima* winter in the north (e.g. N. W. Greenland, Salomonsen 1950: 128; Eurasian arctic, Pleske 1928: 336; Western Arctic, Fay and Cade 1959: 107); the principal requirement appears to be open water in suitable feeding areas.

Freeze-up of the sea arrives late in southern Hudson Bay and James Bay. This, and the prevalence of storms in the region, would tend to encourage at least a proportion of the summer population to remain in the sheltered feeding localities among the various islands in the area. As open water is found in Hudson Bay throughout the winter, it is probable that a wintering population would from the earliest occurrence of the species in the region, be established in accordance with the behaviour noted above for other arctic locations. In support of this contention, the northern eider, normally moving from the west end of Hudson Strait to the open coast of Labrador, may persist some winters near Southampton Island in northern Hudson Bay (Sutton 1932: 66).

It is quite likely that wintering in suitable sheltered regions of Hudson Bay is less hazardous than an extended migration through Hudson Strait to the Labrador coast. The combined effect of larger, more fecund wintering populations in the region, together with the probable lower mortality among non-migrants (Lack 1954: 224) would in the course of time produce a local population with a marked tendancy toward non-migration.

Literature Cited

Bent, A. C. 1925. Life Histories of North American Wildfowl. Order Anseres (Part) United States National Museum Bulletin 130. Washington.

Bray, R. 1943. Notes on the birds of Southampton Island, Baffin Island and Melville Peninsula (comments by T. H. Manning). Auk 60(4): 504-536.

Cooch, F. G. 1965. The Breeding Biology and Management of the Northern Eider (*Somateria mollissima borealis*) in the Cape Dorset Area, Northwest Territories. Wildlife Management Bulletin, Series 2, No. 10.

Driver, P. M. 1960. Behaviour studies in sea-ducklings, Ph.D. Thesis. McGill University, Montreal.

Fay, F. H., and T. J. Cade. 1959. An ecological analysis of the avifauna of St. Lawrence Island Alaska. University of California Publications in Zoology 63(2): 73-150.

Flaherty, R. J. 1918. The Belcher Islands in Hudson Bay: their discovery and exploration. Geographical Review 5(6): 432-458.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada. Bulletin 203.

Gross, A. O. 1938. Eider ducks of Kent's Island. Auk 55(3): 387-400.

Lack, D. 1954. The Natural Regulation of Animal Numbers. Oxford University Press, London.

Lewis, H. F. 1939. Size of sets of eggs of the American eider. Journal of Wildlife Management 3(1): 70-73.

Macpherson, A. H., and I. A. McLaren. 1959. Notes on the Birds of Southern Foxe Peninsula, Baffin Island, Northwestern Territories. Canadian Field-Naturalist 73(2): 63-81.

Manning, T. H. 1946. Bird and mammal notes from the east side of Hudson Bay. Canadian Field-Naturalist 60(4): 71-82.

————. 1949. The birds of north-western Ungava, in "A summer on Hudson Bay" by Mrs. Tom Manning, London. pp. 154-224.

Manning, T. H. 1952. Birds of the west James Bay and southern Hudson Bay coasts. National Museum of Canada. Bulletin 125, pp. 1-114.

Manning, T. H., and D. F. Coates. 1952. Notes on the birds of some James Bay islands. National Museum of Canada. Bulletin 126, pp. 195-205.

Manning, T. H., and A. H. Macpherson. 1952. Birds of the east James Bay coast between Long Point and Cape Jones. Canadian Field-Naturalist 66(1): 1-35.

Pedersen, A. 1962. Polar Animals. London.

Pleske, T. 1928. Birds of the Eurasian tundra. Memoirs of the Boston Society of Natural History 6(3): 111-485.

Salomonsen, F. 1950. The birds of Greenland. Copenhagen, pp. 1-607.

————. 1955. The Evolutionary Significance of of Bird-migration. Dan. Biol. Medd. 22(6): 1-62.

Savile, D. B. O. 1951. Bird observations at Chesterfield Inlet, Keewatin, in 1950. Canadian Field-Naturalist 65(4): 145-157.

Snyder, L. L. 1941. On the Hudson Bay eider. Occasional Papers of the Royal Ontario Museum of Zoology No. 6, pp. 1-7.

Sutton, G. M. 1932. The birds of Southampton Island. Memoirs of the Carnegie Museum 12 Part 2, Sect. 2, pp. 1-275.

Todd, W. E. C. 1963. The birds of the Labrador peninsula. University of Toronto Press, Toronto, pp. 1-819.

Received May 22, 1969
Accepted February 19, 1970

Lichens from the Vicinity of Coppermine, Northwest Territories

John W. Thomson

Department of Botany, University of Wisconsin, Madison Wisconsin, 53706[1]

Abstract. 196 species of lichens are listed from the northern edge of the continent. *Porina mamillosa* var. *sudetica, Lecidea subsorediza, Pertusaria monogona, Lecanora disserpens*, and *Lecanora subplicigera* are new to North America. Considerable extensions of range are reported for the rare species *Gyalecta foveolaris, Leciophysma finmarkicum, Arctomia interfixa, Pertusaria subdactylina, Caloplaca celata*, and *Teloschistes arcticus*. Norstictic acid is reported for *Lecidea subsorediza* and *Pertusaria monogona*.

The settlement of Coppermine on Coronation Gulf at the mouth of the Coppermine River, Lat. 67°49' N., Long. 115°10' W., is well known in arctic annals from the expeditions of Lieutenant John Franklin in 1819 and 1823 to explore the coast east and west from the mouth of the river. The lichens collected on the first of these expeditions by the scientist of the party, Dr. John Richardson, were apparently lost during the almost incredibly harsh adventures of the expedition except for a collection from the winter quarters near Fort Enterprise far to the south and nearer to Great Slave Lake. No subsequent collections of lichens were made on this sector of the arctic coast until the writer visited it during the summer of 1962.

The climate of Coppermine is coastal Arctic, rather cool even in the summer. The winter of 224 days lasts from October until mid May, a spring of 26 days lasts until mid June, a cool summer of 90 days until mid September, and autumn lasts 25 days (Kendrew and Currie 1955). There is a mean duration of 53 frost-free days. The temperature ranges from a mean minimum of -25.9°F in January and -26.6°F. in February to 42.3°F in July and 39.9°F in August (Anonymous 1944). The average annual extremes range from -48.2°F to +78.5°F, and the absolute extremes recorded during the period 1930-1954 were -58°F and +89°F. The mean annual precipitation during this period was 11 inches, the highest record being 15.8 in. and the lowest 8.8 in. The mean annual snowfall was 57 inches, the highest being 87 in. and the lowest 32 in. As expected of a maritime location, fogs are common, the mean number of days with fog being 18, the number varying from 29 to 11 days per year. High winds are common, "gales apparently exceeding 70 m.p.h. have been described by most travelers and explorers in the country between Coppermine and Chesterfield" (Kendrew and Currie 1955).

The geology of the region has been described by Jenney, 1954. "The region has relatively low relief, with elevations in the southern portion varying from 500 to 700 feet in the plains between the mountains, to 1500 feet along their crests. The gently undulating plains area, north of the Bornite and Coppermine Mountains, contains many shallow lakes and monotonous topography is broken only by the long diabase ridges which rise to elevations of 100 or 200 feet above the general level". ". . . all the rocks of the Coppermine Area are assumed to be late Precambrian in age. The known section which rests unconformably on a basal granite of wide extent [Teshierpi Granite] is made up of the Epworth Series of sediments and dolomite overlain by the Coppermine Series of extrusive basalt and diabase flows with overlying interbedded shales, quartzites, sandstones, and limestones. Palaeozoic dolomites and limestones lie unconformably on the youngest members of the Coppermine Series." "In the Bornite, Coppermine and September Mountains the uniform succession of relatively thin and flat dipping basalt lava flows is responsible for the typical Coppermine topography. This consists of a

[1]Supported by grants G19443 and GB2702 from the National Science Foundation. I wish to thank R.C.M.P. David Friesen and David O'Brien, Northern Affairs Agent, for assistance in the field, James A. Larsen accompanied me in the field.

steep south-facing cliff, with a relatively flat area extending to the north before the next succeeding cliff is encountered. The so-called mountains, therefore, rise to an elevation of about 1500 feet in a series of steps. The cliff faces show bare rock exposures as do parts of the flow immediately adjacent to the cliff while the "tread" of the stair or back slope of the flow is usually covered with moss and a very thin layer of overburden."

The complex geology of the area made for excellent and varied collecting. The faces of the lava flows were excellent for the saxicolous lichens. Some of the steps between the flows were well drained and were covered with dry lichen and heath tundras, others were very moist and with tussock tundras. Ancient beaches raised by isostasy following the glacial period varied the topography to the west of the settlement. Pebbles of the gravels of the limestones and dolomites also varied the possibilities for collecting on basic substrata. Inland about seven miles from the sea and up the Coppermine River is Bloody Falls, scene of an Eskimo massacre. Bloody Falls is at one of the diabase flows of the upper half of the Coppermine River Series (which have interbedded red sandstones). It is at one of the east-west crossings of the river by the ridges of the flows. A number of the collections were made in willow thickets and dry tundras near the Falls.

List of Species

Verrucariaceae

Polyblastia bryophila Lönnr. On sides of old lemming burrow in valley, 12888.

Polyblastia hyperborea Th. Fr. On pebbles in lemming run at edge of old terrace west of settlement, 12938; on boulders on terraces, 12955.

Dermatocarpaceae

Dermatocarpon cinereum (Pers.) Th. Fr. On clay frost boil area near cabin north of Bloody Falls, 12468; on humus on steep south-facing bluff of South Bluff, 12886.

Pyrenulaceae

Microthelia aterrima (Anzi) Zahlbr. On soil over rock by cabin north of Bloody Falls, 12548. A species known from the western United States from California, Nevada, Arizona, Colorado, and South Dakota.

Porina mamillosa (Th. Fr.) Zahlbr. var. *sudetica* (Koerb.) Keissl. Over moss in deeply sheltered crevice on north side of hill by settlement, 12528. The spores are up to 6 septate. This species was reported from Colorado as new to North America by Anderson (1967). It was previously known from northern Europe and the Alps and is the only member of this genus to occur on soil and over mosses and humus. The outer layers of the involucrellum are black, the middle layers purple-crimson. The species produces 3-septate spores but in var. *sudetica* the spores have 5-6 septae as in this specimen. The variety is new to North America. An excellent discussion is in Swinscow (1962).

Sphaerophoraceae

Sphaerophorus fragilis (L.) Pers. On rocks by settlement, 12538; on rocks on hill above D.O.T. station, 12978.

Sphaerophorus globosus (Huds.) Vain. In *Eriphorum* tundra in swale above settlement, 12394; on terraces west of settlement, 12432.

Diploschistaceae

Diploschistes scruposus (Schreb.) Norm. On soil on terrace, west side of South Bluff, 12908.

Gyalectaceae

Gyalecta foveolaris (Ach.) Schaer. On soil on north-facing rock face by settlement, 12514. This species of arctic-alpine distribution is known from northern Europe and the Alps, Siberia, Greenland, and was recently reported by Weber and Viereck (1967) from Mt. McKinley as new to North America. It is common on the north slope of Alaska; the stations will be reported upon in another paper. In the herbarium of the University of Wisconsin are two additional records from North America: Northwest Territories, Anderson River, Lat. 69°42' N., Long. 128° 50' W., J. D. H. Lambert 32; and Colorado, Park Co.-Summit Co., east end of Hoosier Ridge, 11 m. N. of Fairplay, ca. 13,000 ft. alt., Shushan and Imshaug 8217. *G. foveolaris* is very similar to *G. geoica*. The two are separated by Vezda (1958) as follows:

Ap. 0.5 - 2.0 mm broad, numerous but not crowded, paraphyses 90-100 μ, spores 12-19 $\times$ 5-9 μ . . . *G. foveolaris*

Ap. 0.2-0.8 mm broad, thickly aggregated, paraphyses 80-100 μ, spores 11-16 $\times$ 4.5-6.5 μ . . . *G. geoica*

Collemataceae

Arctomia interfixa (Nyl.) Vain. On soil at edge of frost crack in tundra by cabin north of Bloody Falls, 12572. This species is a tiny nondescript brown

lichen, granulose-verrucose, with *Nostoc* as the phycobiont. It is paraplectenchymatous throughout. The spores are 3-5 septate, straight, and smaller than in *A. delicatula*, 23-40 × 4.5-5 μ vs. 35-75 × 4.5-6 μ. The latter has 7 septate, curved spores. The type locality is Lawrence Bay, Lawrence Island, Alaska, from the collections of Almquist on the Vega Expedition of 1879, but it was omitted from the Hale & Culberson Checklist. It has also been collected on Novaya Zemlya by Lynge.

Collema ceraniscum Nyl. On mosses on terraces west of settlement, 12431; on edge of frost boils, sides of solifluction lobes and on humus, near cabin north of Bloody Falls, 10916, 12498, 12556.

Collema tenax var. *corallinum* (Mass.) Degel. On soil in moist places in rocks by settlement, 12510; in *Cassiope* area and on moss on side of a boulder near cabin north of Bloody Falls, 10917, 10918.

Collema undulatum var. *granulosum* Degel. On soil at edge of frost boil among willows, north of Bloody Falls, 12580.

Leciophysma finmarkicum Th. Fr. on a little lump of soil over a rock, near cabin north of Bloody Falls, 12560. This small subfruticose member of the Collemataceae has minute lobes attached by tufts of rhizinae, a medulla of reticulately arranged hyphae, and simple spores. It is probably circumpolar, being known from Scandinavia, Bear Island, Novaya Zemlya, Greenland, Ellesmere Island, and has been reported from Siberia (however that specimen in S is a misdetermination of *Lecidea crassipes*). I have additional specimens from the north slope of Alaska at the Pitmegea River (5519, 6495), and at Franklin Bluffs on the Sagavanirktok River (5414, 6393). It has also been collected at Expedition Fiord, Axel Heiberg Island (Marian Kuc 29).

Leptogium crenatulum (Nyl.) Vain. On soil in crevice in rock face near settlement, 12533; on side of hummock in lichen-rich tundra by cabin north of Bloody Falls, 12565.

Leptogium lichenoides (L.) Zahlbr. On moss and humus, west face of South Bluff, 12909; among mosses on clay soil at edge of frost boil, near Bloody Falls, 12465.

Leptogium minutissimum (Flörke) Fr. On soil on top of rock in talus in late snow area south of D.O.T. station, 12398.

Leptogium saturninum (Dicks.) Nyl. In pulvinate masses in low places in swale in lichen-rich tundra near settlement, 10919.

Leptogium tenuissimum (Dicks.) Nyl. In *Cassiope* patch near cabin north of Bloody Falls, 10914, 10915.

PANNARIACEAE

Parmeliella lepidiota (Somm.) Vain. Common in area on humus. Near settlement, 12508; near Bloody Falls, 12481, 12484, 12570.

Psoroma hypnorum (Vahl) S. Gray. On humus in late snow area near settlement, 12519; over mosses in *Rhododendron lapponicum*, Bloody Falls, 12578.

PLACYNTHIACEAE

Placynthium aspratile (Ach.) Henss. On rocks and boulders near settlement, 12892, 12997.

PELTIGERACEAE

Nephroma arcticum (L.) Torss. In late snow area on hill south of settlement, 12390.

Nephroma expallidum Nyl. Among *Betula, Ledum* and *Empetrum* in late snow area on rocks south of D.O.T. station, 12400.

Peltigera aphthosa var. *leucophlebia* Nyl. In willows, Bloody Falls, 12344; in late snow area in rocks south of D.O.T. station, 12395.

Peltigera canina (L.) Willd. In late snow area on hill south of settlement, 12389, 12708.

Peltigera canina var. *rufescens* (Weis.) Mudd On soil among willows, Bloody Falls, 12351, 12478.

Peltigera canina var. *spuria* f. *sorediata* (Ach.) Schaer. Among willows, below Bloody Falls, 12476.

Peltigera lepidophora Nyl. On earth over rock-terraces west of settlement, 12446.

Peltigera malacea (Ach.) Funck. Among rocks in late snow area south of D.O.T. station, 12704.

Peltigera venosa (Huds.) Baumg. On protected side of lemming burrow at edge of terrace west of settlement, 12449.

Polychidium muscicola (Sm.) S. Gray On rock face on hill south of D.O.T. station, 12882, 12939.

Solorina bispora Nyl. Very common in the area on soil of frost boils, along frost cracks on soil, on humus at soil edges. In *Cassiope, Salix* in late snow areas and on soil over rocks. Near the settlement, 12512, 12513, 12520, 12524; near Bloody Falls, 12463, 12470, 12483, 12488.

Solorina saccata (L.) Ach. In more sheltered conditions than the preceding, in crevices on the north side of the hill by the settlement, in old lemming burrow facing west, in late snow *Cassiope* areas near the settlement, 12425, 12451, 12527; in willow thicket below Bloody Falls, 12347.

LECIDEACEAE

Bacidia alpina (Schaer.) Vain. On soil on top of rock at base of talus in late snow area south of D.O.T. station, 12396; on soil in crevice in south side of rocks near settlement, 12515.

Bacidia bagliettoana (Mars & DeNot.) Jatta (= *B. muscorum*) On humus over rocks on hill west of settlement, 12452.

Bacidia melaena (Nyl.) Zahlbr. On soil side of lemming burrow west of settlement, 12453; on soil among willows, Bloody Falls, 12348.

Bacidia populorum (Mass.) Trevis (= *Bacidia acclinis* (Mass.) Zahlbr. of American literature) On willows near Bloody Falls, 12981.

Bacidia sphaeroides (Dicks.) Zahlbr. Usually on humus in late snow areas. Near the settlement, 12428, 12455, 12536; near Bloody Falls, 12573.

Lecidea aenea Duf. On shale and other rocks, near settlement, 12932, 12977.

Lecidea assimilata Nyl. On soil and humus, near settlement, 12379, 12543, 12535.

Lecidea atrobrunnea (Ram.) Schaer. On rocks by settlement, 12976.

Lecidea berengeriana (Mass.) Th. Fr. On soil on north-facing slope by settlement, 12511.

Lecidea confluens (G. Web.) Ach. On rocks, near settlement, 12961; 1 mile west of settlement, 12962.

Lecidea crassipes (Th. Fr.) Nyl. On soil of earth mound in *Eriphorum* tussock tundra in swale south of D.O.T. station, 12971.

Lecidea decipiens (Hedw.) Ach. On soil over rocks, near settlement, 12518, 12523.

Lecidea dicksonii (Gmel.) Ach. On shale and other rocks, near settlement, 12906, 12934, 12944, 12990.

Lecidea flavocaerulescens Hornem. On boulders in frost trains, near the settlement, 12884, 12929, 12949. (Figure 2).

Lecidea glomerulosa (DC.) Steud. On bark of willows near Bloody Falls, 12369.

Lecidea lapicida (Ach.) Ach. On shale and other rocks, near the settlement, 12899, 12930, 12959.

Lecidea lapicida f. *ochracea* (Ach.) Leight. On rocks by settlement, 12963.

Lecidea latypiza Nyl. On rocks by settlement, 12956. Contained atranorin and also trichites in G.A.o-T. test.

Lecidea lulensis Hellb. On south side of rocks by settlement, 12999.

Lecidea pantherina (Ach.) Th. Fr. Very abundant on rocks near settlement. 12897, 12905, 12911, 12913, 12914, 12916, 12928, 12947, 12996. On harder substrata the thalli became more fimbriate-radiate.

Lecidea ramulosa Th. Fr. In low wet places in beach ridges west of the hill and settlement, 12414. A high arctic species.

Lecidea stigmatea Ach. On pebbles and rock outcrops near settlement, 12937, 12942.

Lecidea subsorediza Lynge. On rocks on hill south of settlement, 12940. This specimen contained norstictic acid when tested with the G.A.O-T. reagent. Its contents were not hitherto reported in the literature. This species was described by Lynge from southeast Greenland as a species resembling very much *L. soredieza* but with I + blue, KOH + red reactions instead of I — , and KOH — or + reactions. The norstictic acid content accounts for the KOH + reaction. This species has a non-radiate, white angularly areolate thallus and is sorediate. It was previously known from southeast and northeast Greenland.

Lecidea tesselata (Ach.) Flörke. On rocks on hill south of settlement, 12941.

Lecidea vernalis Ach. Common on moss and soil. Near settlement, 12399, 12427, 12525.

Lopadium pezizoideum (Ach.) Koerb. On humus on soil in shelter of boulder on hill east of settlement, 12686.

Mycoblastus sanguinarius (L.) Norm. On rocks near settlement, 12974; on very old driftwood on an upper abandoned beach level, 12995.

Rhizocarpon disporum (Naeg.) Müll. Arg. On basalt cliffs and also on pebbles near settlement, 12889, 12902, 12960.

Rhizocarpon eupetraeoides (Nyl.) Blomb. & Forss. On rocks. Near settlement 12918, 12925, 12966, 12975.

Rhizocarpon ferax Magn. On rocks by settlement, 12910. Contains rhizocarpic and psoromic acids in G.E. test, no stictic acid in G.A.O-T. test.

Rhizocarpon geographicum (L.) DC. Common on pebbles and rock outcrops near the settlement, 12420, 12933, 12958.

Rhizocarpon grande (Flörke) Arn. On west face of south bluff near settlement, 12895.

Rhizocarpon jemtlandicum Malme On rocks by settlement, 13001.

Rhizocarpon obscuratum (Ach.) Mass. On rocks on hill south of settlement, 12986.

Toninia cumulata (Somm.) Th. Fr. On hummock in tundra rich in lichens near settlement, 12693.

Toninia squalida (Schleich.) Mass. On soil on top of rock near settlement, 12541.

CLADONIACEAE

Cladonia alaskana Evans. In mixed lichen-heath tundra north of settlement, 12368.

**Cladonia alpestris* (L.) Rabh. On tundra by settlement, 12374.

Cladonia amaurocraea (Flörke) Schaer. In late snow areas, on terraces, and among willows. Near settlement 12364, 12367, 12434; near Bloody Falls, 12357.

Cladonia coccifera (L.) Willd. In late snow area and on thin soil over rocks. Near settlement, 12531, 12973.

Cladonia cornuta (L.) Hoffm. In *Salix* on lower terrace west of settlement, 12448.

Cladonia cyanipes (Somm.) Nyl. In late snow area on terraces west of settlement, 12433.

Cladonia deformis (L.) Hoffm. Among rocks in late snowbank area south of D.O.T. station, 12705.

Cladonia furcata (Huds.) Schrad. Among willows below Bloody Falls, 12356.

Cladonia gracilis var. *gracilis* (*C. gracilis* var. *chordalis*). Common in late snow areas and in willows. Near settlement, 12435, 12436, 12450; below Bloody Falls, 12345, 12475.

Cladonia lepidota Nyl. On terrace on west face of south bluff, near settlement, 12950; in *Betula-Salix* thicket north of Bloody Falls, 12545, 12546.

Cladonia mitis Sandst. On rocks south of settlement, 12373; in lichen-rich tundra north of Bloody Falls, 12550.

Cladonia norrlinii Vain. Among willows low on terraces west of the settlement, 12439.

Cladonia phyllophora Hoffm. In late snow area on terraces west of settlement, 12437.

Cladonia pocillum (Ach.) O. Rich At edges of frost boils. On hill south of settlement, 12681, 12682; near Bloody Falls, 12459.

Cladonia pyxidata (L.) Hoffm. On soil, mainly among willows. Near settlement, 12438; near Bloody Falls, 12355, 12359, 12582.

Cladonia rangiferina (L.) Web. In lichen-rich tundra near settlement, 12363, 12392.

Cladonia symphycarpa (Ach.) Fr. On soil in crevice in rocks with south exposure near the settlement, 12522. The specimen contains atranorin and norstictic acid when tested with G.A.o-T. reagent.

Stereocaulon alpinum Laur. Among mosses in late snow area, near settlement, 12407; among willows near Bloody Falls, 12667.

Stereocaulon rivulorum Magn. Among *Betula* in lichen-rich tundra north of Bloody Falls, 12549.

Stereocaulon vesuvianum Pers. On thin soil on top of rocks, south of D.O.T. station, 12403.

Stereocaulon vesuvianum var. *umbonatum* (Wallr.) Lamb. On top of rocks on south face of the hill south of D.O.T. station, 12706. The specimen yielded atranorin in G.E. and G.A.o-T tests, lobaric acid in G.A.W. test and dendroidin in G.E. test.

UMBILICARIACEAE

Agyrophora lyngei Schol. On rocks near settlement, 12982a with apothecia.

Agyrophora rigida (Du Rietz) Llano A specimen collected at Coppermine by Margaret Oldenburg in 1942 (42-226) is in WIS.

Lasallia papulosa (Ach.) Llano On south face of rocks, hill south of D.O.T. station, 12401; on east-facing rocks by settlement, 12502.

Lasallia pennsylvanica (Hoffm.) Llano On rock surface, near settlement, 12697, 12982.

Omphalodiscus decussatus (Vill.) Schol. On rocks near settlement, 12698.

Omphalodiscus krascheninnikovii Sav. On rocks near settlement, 12982c.

Umbilicaria arctica (Ach.) Nyl. On rocks and boulders, near settlement, 12454, 12670.

Umbilicaria cylindrica (L.) Del. On rocks near settlement, 12505, 12982b.

Umbilicaria cylindrica var. *tornata* Ach. On bluff at west of D.O.T. station, 12406.

Umbilicaria deusta (L.) Baumg. On rocks in trickle surface, south of D.O.T. station, 12904.

Umbilicaria hyperborea (Ach.) Hoffm. On rocks by settlement, 12370, 12501; on boulder north of Bloody Falls, 12467.

Umbilicaria proboscidea (L.) Schrad. On rocks near settlement, 12669, 12707.

Umbilicaria vellea (L.) Ach. On rocks near settlement, 12517.

ACAROSPORACEAE

Acarospora badiofusca (Nyl.) Th. Fr. On a granite boulder in the open, west of settlement, 12945.

Acarospora glaucocarpa (Wahlenb.) Körb. On rock west of D.O.T. station, 12411, 12412.

Sporastatia testudinea (Ach.) Mass. On rocks on hill above D.O.T. station, 12924.

PERTUSARIACEAE

Pertusaria atra Lynge With *Rinodina turfacea* on humus on terrace west of D.O.T. station, 12408. This rare species was described by Lynge from material collected by Duman at Churchill. It has a thallus which is verruculose-conglomerate, those with the apothecia are subglobular with the base constricted. The disk is open as in *P. oculata* or *P. bryontha*, 0.35 mm broad, black, concave, the hymenium 250-300 μ high. In *P. bryontha* the disk is reddish and the hymenium 420-480 μ high. There is only 1 (rarely 2) spore per ascus, the spore is large, thick-walled, 100-150 $\times$ 30-65 μ. The thallus is K−, C+ pale reddish, P+ yellow-orange. In addition to the above record, a specimen from the north slope of Alaska on the Sagavanirktok River (Thomson 9119) is in WIS.

Pertusaria bryontha (Ach.) Nyl. Over moss in Salix thicket and over moss at side of old lemming burrow, Bloody Falls, 12477, 12553.

Pertusaria coriacea (Th. Fr.) Th. Fr. Among lichens and *Cassiope*, near settlement, 12685; over old *Dryas* north of Bloody Falls, 12473. Both contain norstictic acid in G.A.o-T. tests.

Pertusaria dactylina (Ach.) Nyl. On rocks south of D.O.T. station, 12881. On soil and humus near the settlement, 12521, 12539, 12542, 12544.

Pertusaria glomerata (Ach.) Schaer. On soil of earth mound in *Eriphorum* tussock tundra in swale south of settlement, 12970; on a little lump of soil over a rock, north of Bloody Falls, 12558.

Pertusaria monogona Nyl. On rocks near settlement, 12967. Contains norstictic acid in G.A.o-T. test. Although lacking spores there are large verrucules which appear as if containing apothecia. Within the "disk" the surface is very rough with coarse soredia-like bodies. The specimen corresponds very well with the Sampao Exsiccat No. 163 (sub. *P. ceuthocarpa* var. *variolosa*) which is similar in morphology and also in chemistry, containing norstictic acid. It somewhat resembles *P. excludens* but Sampao Exsiccat No. 162 which is supposed to be that species lacks norstictic acid and the contents were not identifiable. New to North America.

This member of the Multipunctae section of *Pertusaria* is distinguished by its broad-based, whitish-gray

FIGURE 1. View from hill above Coppermine. Settlement along the shore of Coronation Gulf. Light area is sedge meadow. Foreground of frost-riven boulders of basaltic lava flows covered with lichens and interspersed with lichen heaths.

FIGURE 2. Frost-riven boulders of Figure 1. The size of the lichen thalli indicates long stability rather than motion of these blocks. *Lecidea flavocaerulescens* is prominent on the lower left boulder, a typical habitat for this species.

FIGURE 3. Cliff face of basaltic lava flow, an excellent habitat for *Umbilicaria* and many crustose lichens. *Eriophorum* tussocks in the foreground bear lichens on the tops and sides, *Cetraria delisei* between.

FIGURE 4. Coppermine River valley—south of the settlement, the lowlands flooding often and poor in

FIGURE 5. Region of cabin below Bloody Falls. Lichen-rich heath in foreground, dark willow thicket near the cabin.

FIGURE 6. Birch and willow interspersed with dry lichen-rich tundra. Photo of area downstream (north) from Bloody Falls.

verrucules with soredia-like tops, the habitat on stone, KOH + red, P + orange, reactions, and, when present, the disk pruinose, black, the spores single in the ascus, 105-290 × 54-98 μ. It was previously known as an European species of Atlantic distribution type in Ireland, Wales, France, and Portugal. The report by Erichsen of salazinic acid in this species is incorrect; it was probably based on the color reaction rather than analysis of the content.

Pertusaria panyrga (Ach.) Mass. On moss, humus, soil on sides of hummocks and on soil and plant remains above lemming burrow, near settlement, 12386, 12529, 12687, 12690, 12964; near Bloody Falls, 12485, 12547.

Pertusaria subdactylina Nyl. On old frost boil near cabin north of Bloody Falls, 12475. Thallus K + violet, C —. This species was described from material collected at Port Clarence, Alaska, on the Vega Expedition and published in Flora 1885, p. 603. Its isidiate thallus is short and white, resembling that of *P. dactylina* but has a KOH+ violet reaction instead of KOH+ yellow to reddish. It is not listed in the Hale and Culberson Checklist although not new to North America. This is the second known area for this species.

Pertusaria subobducens Nyl. On humus on soil over rocks near settlement, 12530; on soil on high terrace north of Bloody Falls, 12460. Both specimens contained stictic acid in G.A.o-T. tests.

Pertusaria wulfenii DC. On soil of frost boil in *Eriophorum* tundra near settlement, 12903.

Lecanoraceae

Candelariella aurella (Hoffm.) Zahlbr. On bird perch boulders and on rocks, near settlement, 12921, 12948, 12989.

Candelariella canadensis Magn. On soil over rocks, near settlement, 12456, 12504.

Candelariella vitellina (Ehrh.) Müll. Arg. On rocks on hill south of settlement, 12943.

Haematomma lapponicum Räs. On rocks near settlement, 12700, 12907, 12968, 12983. All specimens contained usnic and divaricatic acids.

Icmadophila ericetorum (L.) Zahlbr. On soil over rocks above D.O.T. station, 12890.

Lecanora badia (Hoffm.) Ach. On rocks above D.O.T. station, 12879.

Lecanora dispersa (Pers.) Somm. On boulder on terraces west of settlement, 12954.

Lecanora disserpens (Zahlbr.) Magn. On boulder on terraces west of settlement, 12953; with *Xanthoria elegans* on pebbles in frost boil on hill south of settlement, 12935. This is an *Aspicilia* type of *Lecanora* with a white radiating thallus of distinct, areolate lobes 0.25-0.35 mm wide, the cortex thin, 20-25 μ, a low hymenium, 70-90 μ, and a negative KOH reaction unlike *L. perradiata* which is KOH + yellow. It was previously reported from east and west Greenland, Novaya Zemlya, (type locality) and Spitzbergen. It has not previously been reported from North America. Additional records in WIS include the north slope of Alaska at Mancha Creek (6485) and the Sagavanirktok River (several collections).

Lecanora epibryon Ach. At edge of frost boil and on year-old driftwood on upper beach, near settlement, 12684, 12993; on soil and plant remains near Bloody Falls, 12349, 12566.

Lecanora frustulosa (Dicks.) Ach. Abundant on cliff facing west, south bluff along Coppermine River, 12952.

Lecanora melanopthalma (Ram.) Ram. On rocks, west face of cliff south of settlement, 12920.

Lecanora polytropa (Ehrh.) Rabenh. On shale, west slope of hill by D.O.T. station, 12917.

Lecanora rubina (Vill.) Ach. On rocks, pebbles and cliffs near settlement, 12877, 12894, 12957.

Lecanora rupicola (L.) Zahlbr. On rock faces near settlement, 12878, 12991, 12998, 13000.

Lecanora subplicigera Magn. On shale west slope of hill by D.O.T. station, 12912. This is a species of the *Aspicilia* group of *Lecanora* with a radiate lobate areolation, the areolae fading marginally but the thallus remaining radiate though thin, pale ashy-gray, KOH —, the cortex paraplectenchymatous rather than perpendicular as in *L. plicigera*. the apothecia tiny, 0.2-0.3 mm broad, the paraphyses moniliform, spores 12-17 × 8-9 μ. It was previously known from Siberia and Novaya Zemlya. New to North America.

Lecanora symmicta (Ach.) On very old driftwood on upper beach level, 12994; on old rotted wood on terrace above beach west of settlement, 12984.

Lecanora verrucosa (Ach.) Laur. On moss in late snow area near settlement, 12429; on humus on top of hill near settlement, 12506; on humus on soil edge near Bloody Falls, 12486.

Ochrolechia frigida (Sw.) Lynge. In mixed lichen tundra, near settlement, 12388.

Ochrolechia frigida f. *thelephorides* (Th. Fr.) Lynge On fossil beach ridges and on soils, near settlement, 12413, 12540, 12676.

Ochrolechia gonatodes (Ach.) Räs. On west end of D.O.T. bluff, 12419.

Ochrolechia grimmiae Lynge. On mosses and side of hummock, near settlement, 12385, 12691.

Ochrolechia upsaliensis (L.) Mass. Very common in region on humus, soil, edges of frost boils, base of *Betula* and of *Salix*, sides of hummocks. Near settlement, 12378, 12683, 12694, 12900; near Bloody Falls, 12353, 12457, 12487, 12551, 12561, 12574, 12575, 12579.

Parmeliaceae

Asahinea chrysantha (Tuck.) Culb. & Culb. Frequent on dry tundras as well as on hummocks in *Eriophorum* tussock tundras. Near settlement, 12383, 12500, 12702, 12703.

Cetraria commixta (Nyl.) Th. Fr. On rocks near settlement, 12371, 12931.
Cetraria cucullata (Bell) Ach. On terraces, willow thickets and dry tundras. Near settlement, 12377, 12440; north of Bloody Falls, 12358, 12361.
Cetraria delisei (Bory) Th. Fr. In low, wet areas, near settlement, 12421, 12516. (Figure 3).
Cetraria hepatizon (Ach.) Vain. On rocks near settlement, 12372.
Cetraria islandica (L.) Ach. In dry tundras and willow thickets. Near settlement, 12382; north of Bloody Falls, 12352, 12362.
Cetraria nigricans (Retz.) Nyl. On west slope of hill by D.O.T. station, 12417.
Cetraria nivalis (L.) Ach. Uncommon, west of settlement, 12441.
Cetraria richardsonii Hook. In lichen-rich tundras and heaths. Near settlement, 12380, 12393; near Bloody Falls, 12474.
Cetraria sepincola (Ehrh.) Ach. On *Betula*, near settlement, 12887; near Bloody Falls, 12563.
Cetraria tilesii Ach. On top of hill near settlement, 12699.
Cetrelia alaskana (Culb. & Culb.) Culb. & Culb. A specimen collected near Coppermine in 1942 by Margaret Oldenberg 229A, is in WIS.
Hypogymnia physodes (L.) Nyl. On rocks and on humus, near settlement, 12537, 12692, 12701.
Hypogymnia subobscura (Vain.) Poelt. On rocks on hill above D.O.T. station, 12709.
Parmelia centrifuga (L.) Ach. On rocks. Near settlement, 12404, 12424.
Parmelia disjuncta Erichs. On boulders and outcrops, near settlement, 12365, 12672; near Bloody Falls, 12466.
Parmelia incurva (Pers.) Fr. On rocks on hill south of settlement, 12695, 12898.
Parmelia olivacea (L.) Ach. On *Betula* near Bloody Falls, 12552, 12576.
Parmelia panniformis (Nyl.) Vain. On east-facing rocks by settlement, 12503.
Parmelia saxatilis (L.) *Ach.* On rock near settlement, 12673, 12674.
Parmelia separata Th. Fr. On rocks, Near settlement, 12532, 12689.
Parmelia stygia (L.) Ach. On shale, west slope of hill by D.O.T. station, 12915, 12919.
Parmelia substygia Räs. On boulder on high beach ridge west of D.O.T. station, 12416.
Parmelia sulcata Tayl. On boulder, near Bloody Falls, 12462.
Parmelia taractica Kremp. On basalt terraces, near settlement, 12946, 12951.

USNEACEAE

Alectoria minuscula Nyl. On rocks on hill above D.O.T. station, 12923.
Alectoria nigricans (Ach.) Nyl. In dry tundra and on top of boulders. Near settlement, 12381, 12422, 12677.
Alectoria nitidula (Th. Fr.) Vain. In lichen-rich tundras, willow thickets and late snow areas. Near settlement, 12376, 12384, 12415, 12678; near Bloody Falls, 12461, 12480, 12497.
Alectoria ochroleuca (Hoffm.) Mass. In dry tundras and willow thickets. Near settlement, 12679; near Bloody Falls, 12474.
Cornicularia divergens Ach. On dry tundras. Near settlement, 12418, 12965.
Dactylina arctica (Hook.) Nyl. Mainly in late snow areas. Near settlement, 12357, 12391, 12410, 12426.
Dactylina ramulosa (Hook.) Tuck. In late snow and *Cassiope* areas. Near settlement, 12423, 12507, 12710.
Evernia perfragilis Llano. On soil at edge of frost boils, on hummocks and on thin soil over rocks. Near settlement, 12360, 12387, 12405, 12447, 12534.
Thamnolia subuliformis (Ehrh.) Culb. In lichen-rich tundra, on edge of frost boils and on soil among willows. Near settlement, 12442, 12443, 12445; near Bloody Falls, 12350, 12479, 12499, 12571. All specimens UV+.

TELOSCHISTACEAE

Blastenia tetraspora (Nyl.) Th. Fr. Over mosses in *Betula* and *Salix* thickets. Near settlement, 12509; near Bloody Falls, 12354, 12469, 12554.
Caloplaca celata Th. Fr. On remains of *Arctostaphylos rubra* and *Salix reticulata* in river bottoms south of settlement, 12969. This is the second report of this species which was known only from Floeberg Beach, Ellesmere Island. It is unmistakable with the pruinose disk, thick whitish margin, lax paraphyses, violet K+ reaction of the tips of the paraphyses and the spore size. Lynge remarked that the location of the type specimen of this species was unknown.
Caloplaca cerina (Ehrh.) Th. Fr. On willows, near Bloody Falls, 12980.
Caloplaca jungermanniae (Vahl) Th. Fr. On mosses on hummock in *Betula-Rhododendron lapponicum* north of Bloody Falls, 12569.
Caloplaca stillicidiorum (Vahl.) Lynge. In lichen-rich tundra by Bloody Falls, 12489.
Caloplaca tirolensis Zahlbr. (*C. subolivacea* (Th. Fr.) Lynge) Over mosses and lichens and old *Dryas*. North of Bloody Falls, 12471, 12564, 12581.
Teloschistes arcticus Zahlbr. Although this rare species was not collected at Coppermine, it was collected by Lambert on Banks Island to the north (Lambert 1966) and a hitherto unreported collection, the first from the mainland of North America, is from Cape Parry to the west of Coppermine by Margaret E. Oldenburg, 42-539, in 1942 (WIS). Another collection by Miss Oldenburg, also in WIS, was from the type locality at Winter Harbor, Melville Island, Oldenburg 45-1274.
Xanthoria candelaria (L.) Th. Fr. On top of boulder on old beach ridge west of D.O.T. station, 12409.

Xanthoria elegans (Link) Th. Fr. On pebbles on frost boil, on rock outcrop, and on cliff below bird nest south of settlement, 12880, 12936, 12987.
Xanthoria sorediata (Vain.) Poelt. On basaltic rock faces. Near settlement, 12901, 12988.

PHYSCIACEAE

Buellia papillata (Somm.) Tuck. On soil on top of rock in late snow area, south of D.O.T. station, 12397, 12972; in late snow area west of settlement, 12430.
Physcia caesia (Hoffm.) Hampe. On top of rock near settlement, 12675; on soil and on boulder, Bloody Falls, 12458, 12557.
Physcia endococcinea (Körb.) Th. Fr. On rock. Near settlement, 12671.
Physcia muscigena (Ach.) Nyl. In dry tundra near settlement, 12680; in willows, Bloody Falls, 12346.
Physcia aipolia (Ehrh.) Hampe. On willows, Bloody Falls, 12979.
Physcia sciastra (Hoffm.) DuRietz. On rocks. Near D.O.T. station, 12402.
Rinodina archaea (Ach.) Arn. On old rotted wood on terrace above beach west of settlement, 12985.
Rinodina lecideoides (Nyl.) Vain. On old sticks in lichen-rich tundra near Bloody Falls, 12577.
Rinodina mniaraea (Ach.) Körb. Over humus, old *Dryas* in *Salix, Betula, Cassiope,* near Bloody Falls, 12464, 12472, 12476, 12555.
Rinodina nimbosa (Fr.) Th. Fr. On soil and humus. Near settlement, 12885, 12893.
Rinodina oreina (Ach.) Mass. On rocks, west face of cliff south of settlement, 12922.
Rinodina roscida (Somm.) Lynge. On plant remains, Bloody Falls, 12482, 12567, 12568.
Rinodina turfacea (Wahl.) Körb. On very old driftwood on upper beach level and on soil over rocks, south of D.O.T. station, 12883, 12992.

Literature Cited

Anderson, R. A. 1967. Additions to the lichen flora of North America. II. The Bryologist 70: 339-343.

Anon. 1944. The meteorology of the Canadian Arctic. Dept. of Transport Air Service Branch, Meteorological Division. Form 9000 Process Publication, 1-85.

Hale, Mason E. Jr., and **W. L. Culberson.** 1966. A third checklist of the lichens of the Continental United States and Canada. The Bryologist 69: 141-182.

Jenney, Charles P. 1954. The Coppermine River Area, Northwest Territories, Canada. Proceedings of the Geological Association of Canada 6(2): 11-26.

Kendrew, W. G. and **B. W. Currie.** 1954. The Climate of Central Canada. Edmond Cloutier, Queens Printer, Ottawa.

Lambert, J. D. H. 1966. **Teloschistes arcticus** Zahlbr. reaffirmed in the Canadian Arctic. The Bryologist 69: 358-361.

Swinscow, T. D. V. 1962. Pyrenocarpous Lichens: 3. The genus **Porina** in the British Isles. Lichenologist 2: 6-56.

Weber, W. A. and **L. A. Viereck.** 1967. Lichens of Mt. McKinley National Park, Alaska. The Bryologist 70: 227-235.

Vezda, A. 1958. Die Tschechoslowakischen **Gyalecta** — und **Pachyphiale** — Arten nebst bestimmungsschlüssel und Ubersicht der Europäischen Arten. Acta Univ. Agric. Sylvicultur., Brno 1: 21-56.

Received July 5, 1969
Accepted July 21, 1969

Noteworthy Mosses from Ellesmere Island, Arctic Canada

Guy R. Brassard

Department of Biology, University of Ottawa, Ottawa, Ontario

Abstract. Five mosses are added to the flora of Ellesmere Island, Arctic Canada: *Campylium arcticum, Hypnum subimponens, Philocrya aspera, Pohlia annotina, Pohlia proligera.* Eight others are new to the northern part of Ellesmere Island: *Abietinella abietina, Conostomum tetragonum, Eurhynchium pulchellum, Funaria polaris, Mnium medium, Plagiopus oederiana, Polytrichum hyperboreum, Tayloria acuminata.*

I have recently spent three field seasons carrying out bryological studies on northern Ellesmere Island. In 1964 I collected mosses at Tanquary Fiord and Lake Hazen (Brassard 1967) and in 1967 at Tanquary Fiord and Van Hauen Pass. In 1969 I was able to visit many localities, mainly along the north coast of Ellesmere Island. Among my collections (nearly 1,500 specimens) were several mosses previously unreported from Ellesmere Island, and numerous others new to the northern part of the island. This paper documents 13 of these and other unpublished records which I have found during the course of my studies. Other new records have already been published (Brassard 1967, 1969).

One hundred and ninety-six mosses were reported from the whole of Ellesmere Island by Steere (1948), but that compilation included many doubtful old reports (especially in *Bryum*), still unconfirmed. The total number of moss species on Ellesmere Island probably does not exceed 200. I have confirmed about 150 moss species from the northern part of the island (above 80° N).

In the following list species not previously reported from Ellesmere Island are preceded by an asterisk. Collection numbers in italics are mine unless otherwise noted. My specimens are deposited at the National Herbarium of Canada (CANM) and the New York Botanical Garden (NY).

Abietinella abietina (Hedw.) Fleisch.

Ellesmere Island. Van Hauen Pass, 6 km E of Otto Fiord campsite, cracks in well-vegetated talus slope, 10 July 1967, *2871*; head of Tanquary Fiord, 8 km SW of Tanquary Camp, between *Cassiope* hummocks, 60 m, 30 July 1967, *3140*; 7 km SW of Tanquary Camp, between *Dryas* hummocks, 500 m, 2 August 1967, *3195*; 4 km S of Tanquary Camp, between *Cassiope* hummocks, 500 m, 14 August 1967, *3312*.

New to northern Ellesmere Island, where it is localized, yet abundant where it occurs. *Abietinella abietina* is widespread throughout the Canadian Arctic, especially in its more southern parts.

**Campylium arcticum* (Williams) Broth.

Ellesmere Island. Van Hauen Pass, 4 km E of Otto Fiord campsite, in sedge meadow, 30 June 1967, *2742;* N coast of Slidre Fiord Fosheim Peninsula, 30 m, 21 July 1952, *Troelsen s.n.* (published as *C. stellatum* by Holmen (1953)) QK!; Lake Hazen area, outflow from Skeleton Lake near Hazen Camp, in sedge meadow with flowing water, 250 m, 26 July 1967, *Longton 1957a*; head of Tanquary Fiord, 4 km SE of Tanquary Camp, dominant in wet meadow, 480 m, 14 August 1964, *1899*; 5 km SW of Tanquary Camp, on gravel, 5 m, 22 August 1964, *1982* c.fr.; 3 km E of Tanquary Camp, in *Luzula* meadow, 330 m, 18 June 1967, *2526*; 2 km N of Tanquary Camp, wet clay in storm beach lagoon, 1 m, 19 July 1967, *3083;* 8 km SW of Tanquary Camp, wet clay beside creek, 25 m, *3145;* Fort Conger, base of walls of ruined hut at campsite, 10 m, 25 May 1969, *4266*; 4 mi NW of head of Muskox Fiord, 23 June 1967, *Blake 1967-1c* (DAO).

These and many other specimens which I have examined establish the species as one of the most widespread on Ellesmere Island, and probably the only representative of the genus on northern Ellesmere. All previous reports of *C. stellatum* (Hedw.) C. Jens. from Arctic Canada should be checked since many are probably *C. arcticum*, a heretofore neglected species. A consistent difference between the two species is the presence in *C. arcticum* of a wide area of enlarged alar cells with an abrupt transition to the median leaf cells. The leaves of *C. arcticum* have a wide V-shaped insertion and are deeply cupped at the base. The sporulating specimen from Tanquary Fiord is most unusual since extremely few species in the large family Amblystegiaceae produce sporophytes in arctic latitudes.

Conostomum tetragonum (Hedw.) Lindb.

Ellesmere Island. Head of Tanquary Fiord, highlands SE of Tanquary Camp, 19 July 1967, *Longton s.n.*

This species and genus is new to northern Ellesmere and extremely rare in the Tanquary area. It is known from most regions of Arctic North America but does not appear to be common anywhere.

Eurhynchium pulchellum (Hedw.) Jenn.

Ellesmere Island. Van Hauen Pass, in sheltered hollow, 1 July 1967, *2795;* Marvin Peninsula, lake near N shore, soil on ridge S of lake, 10 m, 17 May 1969, *4050 & 4065;* Ayles Fiord, near bird perch on ridge above lake near head of fiord, 75 m, 22 May 1969, *4170;* Ward Hunt Island, off the N coast of Ellesmere Island, in cracks of red sandstone outcrop, 100 m, 16 May 1969, *4025*.

These are the first reports from northern Ellesmere although the species seems to be rather widespread, especially along the coast. Steere (1948) listed specimens from Ellesmere, Devon, Baffin, and Southampton Islands and Melville Peninsula.

Funaria polaris Bryhn

Ellesmere Island. Van Hauen Pass, 2 km E of Otto Fiord campsite, around lemming burrows, 1 July 1967, *2774* c.fr.

This is the first report from the Queen Elizabeth Islands since its discovery in southern Ellesmere (Bryhn 1906). The species' range is extended northward by almost five degrees of latitude. *Funaria polaris* is known only from the Nearctic but is widespread from Greenland to Alaska (Steere 1963).

**Hypnum subimponens* Lesq.

Ellesmere Island. Head of Tanquary Fiord, 4 km S of Tanquary Camp, among *Aulacomnium turgidum* between large boulders on stable rock slope, 600 m, 18 July 1967, *3060a*, det. Kjeld Holmen.

Hypnum subimponens has been collected in northwest Greenland and on Baffin Island (K. Holmen, pers. comm.) and is not uncommon in northwestern North America.

Mnium medium B.S.G.

Ellesmere Island. Van Hauen Pass, E of the bay in Otto Fiord, between large boulders on high ridge, ca. 500 m, 11 July 1967, *2882;* head of Tanquary Fiord, 3 km SE of Tanquary Camp, enriched mound near pond margins, 500 m, 20 July 1967, *3088*; Ward Hunt Island, off the N coast of Ellesmere Island, depression on S-facing solifluction slope, 75 m, 30 May 1969, *4297a*.

The above specimens (all synoicous) indicate that my earlier assumption regarding the commonness of *M. medium* in the Canadian High Arctic (Brassard 1967a) was not unwarranted. The species was long known in Arctic Canada only from southern Ellesmere Island (Bryhn 1906).

**Philocrya aspera* I.Hag. & C.Jens. *ex* C.Jens.

Ellesmere Island. Van Hauen Pass, near river at N shore of the bay in Otto Fiord, among *Cassiope* on steep N-facing rocky slope, 75 m, 1 July 1967, *Longton 1577*.

This is only the second report from Canada. The only other known locality for *Philocrya* in Canada is on Baffin Island (Harmsen & Seidenfaden 1932), but it is probably more widespread than these few records would indicate as it also occurs in several parts of Greenland and Arctic Alaska.

Plagiopus oederiana (Sw.) Limpr.

Ellesmere Island. Van Hauen Pass, 5 km E of Otto Fiord campsite, depressions in hummocky *Dryas* heath, 5 July 1967, *2581* c.fr.; head of Tanquary Fiord, 6 km S of Tanquary Camp, NW-facing hummocky slope, 700 m, 14 August 1967, *3321* c.fr.

P. oederiana is new to northern Ellesmere Island and its known range is extended northward from southern Ellesmere Island. It is widespread throughout the Canadian Arctic but not abundant anywhere.

**Pohlia annotina* (Hedw.) Lindb.

Ellesmere Island. Head of Tanquary Fiord, 8 km NE of Tanquary Camp, clayey areas on stable rock slope, 600 m, 12 August 1967, *3302b;* 19 miles N of head of Baad Fiord, shear moraine close to NW edge of ice cap (in moraine area on ice lobe), 600-700 m, 12 July 1967, *Blake 1967-8b* (DAO); Doidge Bay, in deep cracks of steep unstable rock slope, 2 m, 23 May 1969, *4190*.

All the above specimens have abundant gemmae. Neither this species nor the following (*P. proligera*) was reported from the Canadian Eastern Arctic by Steere (1948); the genus *Pohlia* seems to be among the most variable in the Canadian Arctic and completely sterile material is often unidentifiable.

**Pohlia proligera* (Limpr.) H.Arnell

Ellesmere Island. Head of Tanquary Fiord, 6 km S of Tanquary Camp, on near-vertical clay banks, 600 m, 14 August 1967, *3318a*.

This species was also found with abundant typically vermicular bulbils.

Polytrichum hyperboreum R.Br.

Ellesmere Island. Ayles Fiord, lake near head of the fiord, on *Salix-Alopecurus* slope, 100 m, 22 May 1969, *4162*; Doidge Bay, hanging from soil between rocks on very unstable NW-facing slope, 2 m, 23 May 1969, *4184*; Lake Hazen area, Johns Island, in pure sand, 10 m, 25 May 1969, *4271*; Lake Hazen, 1 mile NW of Hazen Camp, slightly moist runnel on sandstone hill, 22 June 1962, *Savile 4440* c.fr., *4441* (DAO); NE of Hazen Camp, SW-sloping creek bank, 4 August 1962, *Savile 4826* c.fr. (DAO); ½ mile N of Hazen Camp, low, S-facing clay bank, 200 m, 24 July 1967, *Longton*

1913 c.fr.; Van Hauen Pass, 2 km W of Hare Fiord campsite, on clay bank above small stream, 28 June 1967, *2708* c.fr.; head of Tanquary Fiord, 8 km SW of Tanquary Camp, clay bank, 500 m, 2 August 1967, *3199* c.fr.; 5 km E of Tanquary Camp, dominant on moist to dry clay slope, 300-500 m, 5 August 1967, *3215* c.fr.; 8 km NE of Tanquary Camp, clayey areas on stable rock slope, 600 m, 12 August 1967, *3303* c.fr.; Tanquary Fiord, Gull Glacier, on disintegrating bedrock just NE of glacier snout, 200 m, 6 August 1967, *3226*.

In areas such as Tanquary Fiord and Lake Hazen *Polytrichum hyperboreum* is common and conspicuous on clayey slopes. It is quite distinct from *P. piliferum* Hedw. and fully merits recognition as a separate species. On northern Ellesmere, where both species occur, they differ in gross appearance, fertility, and habitat. *P. hyperboreum* is highly branched and usually very robust (stems to 10 cm or more tall), almost always with abundant sporophytes, and grows on clay or sand. *P. piliferum*, which is much more localized, is stunted, unbranched, sterile, and grows on gravel. The development of the awns also serves to differentiate the two species and this and the other differences mentioned above are very constant, with no intermediate specimens. *Polytrichum hyperboreum* is a very widely distributed high arctic circumpolar species.

Tayloria acuminata Hornsch.

Ellesmere Island. Van Hauen Pass, 2 km E of Otto Fiord campsite, around lemming burrows, 1 July 1967, *2776* c.fr.; head of Tanquary Fiord, 8 km SW of Tanquary Camp, between *Cassiope* hummocks, 60 m, 30 July 1967, *3139b* c.fr., verif. H. Crum.

The species was previously unknown from northern Ellesmere Island. Further comments on *Tayloria*, one of the rarest genera in Arctic Canada, are given in Brassard (1967).

Acknowledgements

My field studies have been supported by the National Research Council (grant to R. Beschel), the New York Botanical Garden, and the National Museum of Natural Sciences. The Defence Research Board of Canada provided logistic support during all three field seasons. I thank the bryologists who have verified or revised several of my determinations, Dr. Royce Longton, my companion in 1967, and Drs. W. C. Steere and Kjeld Holmen for helpful discussions.

Literature Cited

Brassard, G. R. 1967. New or additional moss records from Ellesmere Island, N.W.T. Bryologist 70: 251-256.

———. 1967a. A contribution to the bryology of Melville Island, N.W.T. Bryologist 70: 347-351.

———. 1969. *Mielichhoferia elongata*, a copper moss new to North America, found in Arctic Canada. Nature 222: 584-585.

Bryhn, N. 1906-07. Bryophyta in itinere polari norvagorum secundo collecta. Report Second Norwegian Expedition in the "Fram" 1898-1902, No. 11, 260 p.

Harmsen, L. and **G. Seidenfaden.** 1932. The Godthaab Expedition 1928. The mosses. Meddelelser om Grønland 82(2), 42 p.

Holmen, K. 1953. Bryophytes of Fosheim Peninsula, Ellesmere Island. Bryologist 56: 242-248.

Steere, W. C. 1948. Musci. In: Botany of the Canadian Eastern Arctic, Natl. Museum Canada Bull. 97: 370-490.

———. 1963. The geographic distribution of *Funaria polaris*. Bryologist 66: 213-217.

Received November 1, 1969
Accepted December 26, 1969

The Status of *Populus balsamifera* and *P. trichocarpa* in Alaska

Leslie A. Viereck and Joan M. Foote

Institute of Northern Forestry, Pacific Northwest Forest & Range Experiment Station, Forest Service, U.S. Department of Agriculture, College, Alaska.

Abstract. A nine-point hybrid index was applied to pistillate flowers of balsam poplar and black cottonwood in Alaska. Coastal populations from southeast Alaska had perfect scores for black cottonwood whereas populations in interior central Alaska were pure balsam poplar. Areas of overlapping range and of hybridization occur in the northern interior portion of southeastern Alaska and in the Cook Inlet region. *Populus balsamifera* L. subsp. *trichocarpa* (Torr & Gray) Brayshaw is the correct status for black cottonwood in Alaska.

Together balsam poplar (*Populus balsamifera* L.) and black cottonwood (*P. trichocarpa* Torr. & Gray) cover approximately 2.1 million acres or 8 percent of the commercial forest land in Alaska (Hutchison 1967). However, in many areas of Alaska, it is difficult to separate the two taxa. According to Hultén (1943 and 1968) and Anderson (1959, pp. 184-185) balsam poplar is the interior tree whereas black cottonwood is limited primarily to coastal areas. The two species are known to hybridize freely in Alberta, British Columbia, and elsewhere in Canada; and all degrees of intermediacy occur in abundance wherever their ranges overlap (Brayshaw 1965a, 1965b). This paper reports some preliminary data of the status of the two taxa in Alaska and points out areas from which additional information is needed.

Range and Ecology

Balsam poplar is an eastern North American species extending westward across Canada to interior Alaska but occurring only rarely west of the Rocky Mountains. In Alaska, balsam poplar extends from the Canadian border to the Bering and Chukchi Seas (Figure 1). It extends much farther north than spruce and occurs in isolated clumps along several rivers north of the Brooks Range. Its southern limits are less clear because of the confusion with the coastal black cottonwood, but it reaches the Pacific coast in the Cook Inlet area and on the Alaska Peninsula. It has also been reported by Hultén (1968) from Kodiak Island.

Balsam poplar is primarily a successional species invading river alluvium and glacial moraines. It grows quickly on alluvial sites and may reach a diameter of 24 to 28 inches and a height of 80 to 100 feet in 100 to 150 years. It is usually replaced along the rivers by white spruce (*Picea glauca* (Moench) Voss). Balsam poplar is also a fire succession species. It is found intermingled with aspen (*Populus tremuloides* Michx.) on upland slopes throughout most of the interior Alaska, not on the driest sites but on the more east- and west-facing slopes where aspen intermingles with paper birch (*Betula papyrifera* Marsh.). In some areas, such as the Matanuska Valley, it may be the most abundant tree following fire. Balsam poplar also occurs beyond the altitudinal and latitudinal limit of spruce in mountainous areas in interior Alaska and north of the Brooks Range. In the mountains, the tree grows in clumps adjacent to tundra ponds, along alpine streams, and as a scrubby tree at the base of talus slopes. It is often found 500 to 1,000 feet above the spruce, which usually marks tree line.

Black cottonwood is found primarily west of the Rocky Mountains as far south as Baja California. It is not restricted to the coast but extends eastward into Wyoming, Montana, Idaho, and southwestern Alberta. The range overlaps with outliers of balsam poplar in Montana, Idaho, Alberta, Yukon Territory, British Columbia, and Alaska. In Alaska, it is a coastal tree occurring throughout southeastern Alaska and extending westward to Kodiak Island and inland in the Cook Inlet area (Figure 1). It is a successional tree of glacial moraine, outwash,

and river alluvium. Extensive stands, large enough to be of commercial importance, occur in the Stikine, Taku, Haines, Skagway, Yakutat, and Seward areas. One of the largest black cottonwoods in North America, with a diameter of nearly 11 feet and a height of 101 feet, grows in the Haines area (Pomeroy and Dixon 1966).

Description

Both species are large trees with gray bark that darkens and roughens with age. New twigs are pale brown but soon become gray. The vegetative buds are resinous, have a fragrant odor, and are covered by five to seven pubescent and ciliate resinous scales. The leaves are ovate with an accuminate tip, rounded at the base, and with fine dentations along the edges. Leaf color is dark green above and light green beneath. There is considerable variation in leaf shape and size. Both trees sucker from the roots to a considerable extent.

The trees are usually dioecious and flower during May and June. Both staminate and pistillate flowers are produced in separate aments or catkins. The pistillate catkins elongate to 5 to 8 inches at maturity. Male flowers soon drop to the ground and disintegrate and are thus available for collection only during a short period in early spring. The female aments remain on the tree until after the seeds are shed in late June or early July. The ament remains intact as it falls to the ground and is often preserved in the litter under the tree throughout the remainder of the summer.

The two taxa are similar in vegetative characteristics which, therefore, cannot be used to distinguish them. Leaf width and number of bud scales, characters used in some manuals, are not reliable as the ranges of these dimensions and numbers overlap completely. In western Canada, Brayshaw (1965a) was unsuccessful in separating the two taxa on the basis of leaf characteristics. Chromosome numbers, $2n = 38$, are reported to be the same in both (Smith 1943; Darlington and Wylie 1956); but no chromosome counts have been made on Alaska specimens.

Flower and fruit characteristics are the only reliable distinguishing features. Balsam poplar has 12 to 30 stamens per staminate flower whereas typical black cottonwood has 40 to 60. In balsam poplar, the pistillate flowers have a two-parted ovary that develops into a capsule that is lanceolate in cross section and glabrous. Black cottonwood, on the other hand, has a three- and sometimes four-parted ovary which produces a globose densely pubescent capsule.

Methods

In Canada, Brayshaw (1965a) applied an eight-point hybrid index to each of his specimens based on the female floral characteristic. A slightly modified nine-point index was used in this study as shown in tabulation below — pure balsam poplar has an index of 0 to 2 and black cottonwood an index of 8 or 9. Intermediates have an index range of 3 to 7.

Character	*Expression*	*Points Assigned*
Capsule shape	Narrowly ovoid	0
	Ovoid	1
	Globose or subglobose	2
Capsule pubescence	None	0
	Sparse	1
	Abundant	2
Number of carpels	Always two	0
	Mostly two, occasionally three	1
	Two and three equally frequent	2
	Mostly three, occasionally two	3
	Always three	4
	Mostly three, sometimes four	5

Maximum index value, 9 = *P. trichocarpa*
Minimum index value, 0 = *P. balsamifera*

Hybrid index determinations were made from a sample of 10 aments from one female

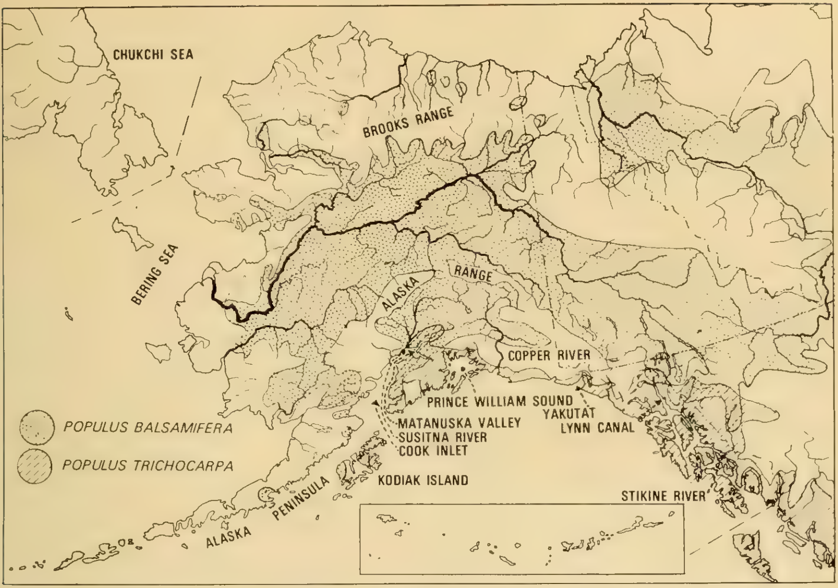


FIGURE 1. Distribution of *Populus balsamifera* and *Populus trichocarpa* in Alaska and adjacent Canada (from Fowells 1965, Hultén 1968, Taylor and Little 1950, and Wiggins and Thomas 1962).

tree at each site. If no mature capsules were present on the tree, they were collected from the ground directly beneath. Hybrid index of herbarium specimens was determined from whatever material was available — usually one to three aments.

Collections were made during the summer of 1967 and 1968, whenever other fieldwork took us into different areas of Alaska. Most of the collections were concentrated along the roads of interior and southeast Alaska; samples were collected from 26 geographically separated stands. In addition, 21 specimens, collected by E. L. Little in 1961, were examined and given index numbers. These specimens, as well as our own, are on file in the herbarium at the Forestry Sciences Laboratory at College, Alaska. Twelve herbarium specimens from the University of Alaska were also classified by the hybrid index.

Results

The hybrid index numbers are mapped in Figure 2. Nearly pure populations of balsam poplar occur north of the Alaska Range, on the south slope of the Brooks Range, and in the Copper River basin. Pure populations of black cottonwood are located along the coast of southeast Alaska and adjacent to Prince William Sound. Hybridization occurs in the Haines area, in the mountain pass between Valdez and the Copper River basin, and especially in the Cook Inlet region, the Matanuska Valley, and the Kenai Peninsula. Only one specimen was collected from the Susitna River valley 10 miles south of the summit of the Alaska Range. This collection, with an index value of 3, indicates that the Susitna valley is probably another region of hybridization.

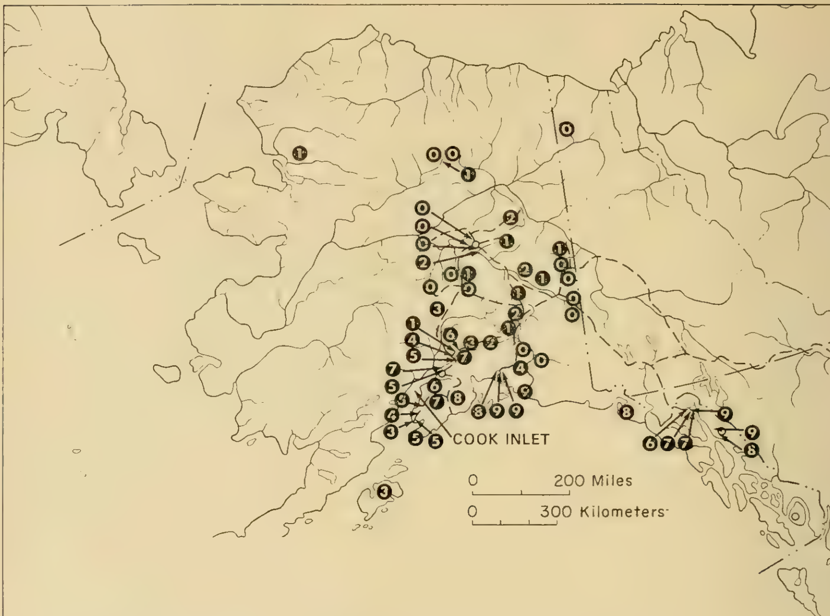


FIGURE 2. Hybrid index values for *Populus balsamifera* and *Populus trichocarpa*.
0 — 2 *Populus balsamifera* 8 — 9 *Populus trichocarpa* 3 — 7 Intermediates

It is obvious from the map that additional information is needed from areas where the ranges overlap or are separated by low mountain passes such as the Stikine River, the Lynn Canal and at Yakutat in southeastern Alaska, the Susitna valley, and Kodiak Island. In addition, population collections are needed from several localities to determine the degree of variation within stands and within local areas, especially in regions of hybridization.

Discussion

A possible explanation of this distribution and hybridization is discussed by both Hultén (1937) and Brayshaw (1965a). During one or more of the major ice advances of the Pleistocene epoch, perhaps as late as the Wisconsin, the common ancestral stock of both species was separated by the ice sheets. What is now balsam poplar was isolated in the Tanana-Yukon upland refugia and south of the ice border but east of the cordilleran ice sheet of the Rocky Mountains. The black cottonwood ancestor was isolated west of the Rockies. As the ice sheets diminished, both species would have expanded rapidly as pioneer species on glacial moraine and outwash. Where the two populations have met in post-Wisconsin time, hybridization and introgression have occurred freely. In Alaska, this has been limited by the mountain barrier along the coast and by the lateness of the ice retreat at the end of the Wisconsin age.

The degree of hybridization and the great similarity in morphological characteristics between these two taxa require a reappraisal of their taxonomic rank. Although there is not complete agreement among taxonomists on the absolute criteria for distinguishing between the rank of species and subspecies, there is general agreement on the following criteria suggested by Stebbins (1950).

At the species level, there should be two separate systems of populations separated from each other by a complete break in the variation pattern. These discontinuities must have a genetic basis, and there must be some isolating mechanism which hinders or prevents the flow of genetic material from one population to another.

Two subspecies, on the other hand, have a number of morphological and physiological characteristics in common, usually occupy a subdivision of the total species range, differ in several characteristics, but are connected by intermediate forms.

In Alaska, the distribution and characteristics of balsam poplar and black cottonwood fit more closely to the criteria of subspecies than of species. We agree with both Hultén (1967 and 1968) and Brayshaw (1965a) that morphological differences are not of enough magnitude nor breeding isolation of a sufficient degree to separate the two as distinct species. The evidence supports the conclusion of Hultén and Brayshaw that balsam poplar and black cottonwood are conspecific and that *Populus balsamifera* L. subsp. *trichocarpa* (Torr. & Gray) Brayshaw is the correct status for black cottonwood.

Literature Cited

Anderson, J. P. 1959. Flora of Alaska and adjacent parts of Canada. Ames, Iowa, Iowa State University Press.

Brayshaw, T. C. 1965a. The status of the black cottonwood (*Populus trichocarpa* Torrey and Gray). Canadian Field-Naturalist 79: 91-95.

————. 1965b. Native poplars of southern Alberta and their hybrids. Canada Dep. Forest. Pub. 1109. Ottawa.

Darlington, C. D. and **A. P. Wylie.** 1956. Chromosome atlas of flowering plants. The MacMillan Co. New York. 519 p.

Fowells, H. A. (ed.) 1965. Silvics of forest trees of the United States. U.S. Dep. Agr. Handb. 271.

Hultén, Eric. 1937. Outline of the history of Arctic Biota and Boreal Biota during the Quaternary Period. Bokforlags Aktiebolaget Thule. Sweden, Stockholm.

————. 1943. Flora of Alaska and Yukon. Part III. Lund Univ. Arrskr. N. F. Avd. 2 Bd. 3g.

————. 1967. Comments on the flora of Alaska and Yukon. Arkiv for Botanik Serie 2 Band 7 nr 1: 1-147.

————. 1968. Flora of Alaska and neighboring territories. Stanford, Calif., Stanford University Press.

Hutchison, O. Keith. 1967. Alaska's forest resource. Pacific Northwest Forest & Range Exp. Sta. USDA Forest Serv. Resource Bull. PNW-19.

Pomeroy, Kenneth and **Dorothy Dixon.** 1966. These are the champs. American Forests 72(5): 14-35.

Smith, E. C. 1943. A study of the cytology and speciation in the genus *Populus* L. Jour. Arnold Arboretum 24: 275-304.

Stebbins, G. Ledyard. 1950. Variation and evolution in plants. New York, Columbia University Press.

Taylor, R. F. and **E. L. Little, Jr.** 1950. Pocket guide to Alaska trees. U.S. Dep. Agr. Agr. Handb. 5.

Wiggins, Ira L. and **John Hunter Thomas.** 1962. A flora of the Alaskan arctic slope. Arctic Inst. North Amer. Spec. Pub. 4.

Received November 15, 1969
Accepted December 5, 1969

Notes

Succession in Two Exclosures near Unalakleet, Alaska

Abstract. Two exclosures established during the 1920's were reexamined in 1965. In the dwarf shrub-lichen type browse species suppressed recovery of lichens. Full recovery of lichens had not occurred within 33 years. In several disturbed quadrats in the *Dryas* fjeld-field type, recovery after 36 years was primarily from plants that were already established rather than from new plants.

During the 1920's and 1930's, L. J. Palmer and others established several fenced exclosures on Alaskan reindeer ranges. Within these exclosures 1 m^3 quadrats were laid out and treated in various manners to stimulate different intensities of grazing or trampling. In some cases, permanent plots were also established outside the exclosure. The quadrats were examined periodically, and in 1945 Palmer and Rouse reported the changes that had occurred in the quadrats.

During the summer of 1965, I attempted to relocate as many of the exclosures as possible to determine the changes that had taken place in the vegetation since their report. I found eight of the exclosures, but most were in very poor condition as no one had maintained them for over 20 years. However, two were of value as the quadrat boundaries could be relocated and provide some indication of succession in tundra vegetation.

One of the exclosures was about three miles north of Unalakleet. Although the fence had fallen down, the exclosure can still serve its purpose as reindeer have not been in the area for over 20 years. It is located in a dwarf shrub lichen vegetation type which Palmer called "tundra-lichen". It is usually found on the slopes of foothills and is the primary winter range on most Alaskan reindeer ranges. The soil is a deep loam with a good humas layer. Dwarf shrubs are abundant, primarily bog blueberry (*Vaccinium uliginosum*), dwarf alpine birch (*Betula nana*), narrow-leaved Labrador tea (*Ledum palustre*, subsp. *decumbens*), and crowberry (*Empetrum nigrum*). The dwarf shrubs are interspersed with large growths of lichens (*Cladonia rangiferina, C. arbuscula, C. alpestris, C. amaurocraea, C. gracilis, Cetraria cucullata* and *C. islandica*). Sedges, grasses and forbs occur throughout. The principal species include *Carex bigelowii, C. podocarpa, Arctagrostis latifolia, Festuca altaica, Hierochloe alpina, Pedicularis labradorica, Polygonum bistorta*, subsp. *plumosum* and *Parrya nudicaulis*. The entire area is usually underlain by a moss mat, mostly *Sphagnum* spp. and *Polytrichum* spp.

Palmer established this exclosure in 1922 and it contained four 1 m^2 quadrats.

Scraped Quadrat. This quadrat was established early in the spring while the ground was frozen. All the vegetation above the frozen surface was removed. Those parts of the lichens and vascular plants that were frozen in the ice on top of the ground remained intact. The original vegetation cover was complete and composed of 80% lichens, 10% sedges, and 10% browse according to Palmer and Rouse (1945).

In September 1932, the cover was 95% and composed of 50% lichens, 30% browse, 15% grass and sedges, and 5% moss. The recovery of the lichens was slow, and Palmer and Rouse (1945) reported that in 10 years they regained only half of their former height and abundance.

In June 1965, the cover was complete and composed of 65% lichens, 30% browse, and 5% sedges. The lichens averaged 1.5 inches more in length than when the quadrat was originally established, but they have not been able to regain their former abundance.

Clipped Quadrat. The top half of the vegetation was removed in 1922. Originally the cover was complete and composed of 80% lichens, 10% browse, and 10% sedges. In 1927, the composition was 30% lichens, 65% browse, and 5% sedges. Palmer and Rouse (1945) stated that 10 years after establishment the lichens averaged three inches in height. The cover was complete and composed of 50% lichens, 45% browse, and 5% grasses and sedges.

In June 1965, the cover was 95%. The browse species had evidently crowded out some of the lichens that were present in 1932, as the composition is now 10% lichens, 85% browse, 3% sedges, and 2% moss.

Denuded Quadrat. The cover was complete and similar to the two previous quadrats when established in the summer of 1922. At that time all the vegetation was scraped off to ground level. In

September 1932, the cover was 80% and composed of 35% lichens, 40% browse, 15% sedges and grass, and 10% moss. The lichens averaged about one inch in height according to Palmer and Rouse (1945).

In June 1965, the cover was 95% with 30% lichens, 65% browse, and 5% sedges.

CHECK QUADRAT. This one was left undisturbed to serve as a check. The cover was complete and composed of 80% lichens, 10% browse, and 10% sedges. The lichens averaged 3 to 4 inches in height. In 1927, the composition had changed to 50% lichens, 40% browse, and 10% sedges. Palmer and Rouse (1945) stated that they suspected the quadrat was accidentally trampled when it was established as many of the lichens had died.

In 1932, the composition was the same as in 1927; this indicates the importance of avoiding trampling of lichens when laying out permanent study plots.

In June 1965, the cover was complete and composed of 70% lichens, 27% browse, 1% sedges, and 2% moss. The lichens are finally regaining their original abundance and now average 5 inches in height.

In all of the quadrats the reindeer lichens (*Cladonia alpestris*, *C. rangiferina* and *C. arbuscula*) are replacing the *Cetraria* types (*Cetraria cucullata* and *C. islandica*).

Another exclosure was established in 1929 in a *Dryas* fjeld-field type on top of a small hill 13 miles northwest of Unalakleet. This type covers most of the upper slopes and summits of hills throughout the area. *Dryas octopetala* forms complete mats in some places and in others, the mat is interrupted by large, rocky terraces or strips. Other common shrubs or subshrubs are *Salix phlebophylla*, crowberry, narrow-leaved Labrador tea, alpine bearberry (*Arctostaphylos alpina*), and alpine azalea (*Loiseleuria procumbens*). Grasses (*Agrostis borealis*, and *Hierochloe alpina*) and forbs (*Tofieldia pusilla*, *Campanula lasiocarpa*, *Oxytropis nigrescens*, and *Pedicularis kanei*) occur scattered throughout. The more important lichens include *Alectoria nigrescens*, *A. ochroleuca*, *Cornicularia divergens*, *Cetraria nivalis*, *Asahinea chrysantha*, *Cladonia rangiferina*, *C. amaurocraea* and *Thamnolia vermicularis*.

SPADED QUADRAT. The cover, when the plot was established in 1929, was 50% and composed largely of *Dryas* and *Tofieldia*. In 1932, Palmer and Rouse described the vegetation as being composed of six *Carex* clumps, three forbs, two *Dryas*, one *Salix*, and six clumps of mosses.

In June 1965, 36 years after establishment, the cover was only 40% and mainly moss and *Dryas*. These were encroaching in from plants on the periphery rather than from new plants that had become established in the quadrats. There were a few forbs and some small lichens present.

CUT QUADRAT. Originally the cover was 60%, again mostly *Dryas* and *Tofieldia*. All vegetation was cut to the ground surface. By 1932, the cover was 30%, mainly *Dryas* according to Palmer and Rouse (1945).

In June 1965, the cover was 75% with *Dryas octopetala* composing 70% of the cover. *Luzula nivalis* was well distributed throughout. *Thamnolia vermicularis* was the predominant lichen in all the quadrats.

CHECK QUADRAT. This quadrat had a 70% cover and was left undisturbed to serve as a check. *Dryas* was predominant with some *Oxytropis*, *Tofieldia*, and *Festuca* present. In 1932, the cover had increased to 85% due to the *Dryas* mat spreading over the bare ground.

In June 1965, the cover was 95% with 90% *Dryas*. The only lichens are a few scattered *Thamnolia vermicularis* individuals.

From the exclosure in the dwarf shrub-lichen type, it is noted that recovery of the vegetation usually occurs within 10 years, although the species composition is altered. The browse species being increasers are able to repress recovery of the decreasers, the fruticose lichens. Crowberry and alpine bearberry are especially detrimental to lichens as they form mats through which lichens have a difficult time penetrating. At Unalakleet, full recovery of the lichens had not occurred when examined 33 years after disturbance. Apparently this area is becoming drier as in all quadrats the sedges decreased and the browse species comprise a greater percent of the cover than when established. The clipped quadrat is of interest because it represents the most moderate damage, yet lichens have recovered the least. Evidently the browse species were stimulated by clipping as their contribution to the cover rose from 10% when established to 85% in 1965. Apparently lichens are better able to compete with the browse species for re-establishment when both are severely disturbed as in the denuded and scraped quadrats.

Stereocaulon and *Cetraria* lichens are the early re-establishing forms which are later replaced by the more desired *Cladonia* types.

In the *Dryas* fjeld-field type, recovery is very slow from overuse and most of the new growth comes from plants that are already established rather than from new plants. Bare ground and rock strips are almost always first colonized by the expanding *Dryas* mat. It is an important reindeer range type because the snow cover is blown off the mountain tops exposing the vegetation throughout much of the winter, and some of the lichens are prefered by reindeer. It must be carefully managed to prevent severe damage to the *Dryas* mat due to its slow recovery rate.

Literature Cited

Palmer, L. J. and **C. H. Rouse.** 1945. Study of the Alaska tundra with reference to its reactions to reindeer and other grazing. United States Department of the Interior, Research Report No. 10, 48 p.

ROBERT E. PEGAU

Alaska Department of Fish & Game
Nome, Alaska
Received February 24, 1969
Accepted November 4, 1969

Capture, Morphology and Food of Lake Charr Alevins in Lake Heney, Quebec[1]

Abstract. In July 1968, eight lake charr (*Cristivomer namaycush*) alevins were collected by otter trawl net at depths of 60-110 ft from Lake Heney, Gatineau County, Quebec, providing the first record of the capture of lake charr alevins (40.8 - 48.6 mm total length) from the wild populations in southwestern Quebec and southeastern Ontario. Morphologically they were similar to a hatchery raised sample of lake charr alevins. *Mysis relicta* and *Pontoporeia affinis* were found in their stomachs.

During the course of field studies on the ecology and behaviour of the sculpins, *Myxocephalus thompsonii* and *Cottus ricei*, in Lake Heney (also called Small Whitefish Lake), Gatineau County, Quebec, the senior author collected eight lake charr (*Cristivomer namaycush*) alevins (Lagler, Bardach, and Miller, 1966; Ricker 1968) in trawl samples in July 1968. This is the first record of lake charr alevins from the wild populations in southwestern Quebec and southeastern Ontario. Only rarely have the young-of-the-year and yearling fish been collected from other areas (Eschmeyer, 1956). However, a few earlier reports on such collections from elsewhere are: the capture of lake charr eggs and sac fry by pumping (Rawson and Elsey, 1950; Eschmeyer, 1955 and 1956; DeRoche, 1969) and alevins by trawling at depths of 60-100 ft (Eschmeyer 1955 and 1956; Rupp and DeRoche, 1960).

Method of capture of alevins. Otter trawl net used for the collection of lake charr alevins was made of polypropylene thread and had 1½ inches stretched mesh. It was 8 ft across the head rope and the bag was 16 ft long with an inner liner of ¼ inch stretched mesh cotton seine material sewed into the last 4 ft of the bag. The otter trawl boards were 12 x 24 inches mahogany, ¾ inch thick, with 2 inches wide metal shoes and braces and were purchased from the Marinovich Trawl Co., Biloxi, Miss. Trawling was done with a 16 ft. skiff and 9½ h.p. outboard motor at an approximate towing speed of 4 m.p.h. A single ⅜ inch diameter polypropylene rope, 3 times the maximum depth of water trawled, was attached from the boat to a 20 ft bridle at the trawl. this bridle was found sufficient to allow the boards to spread the net.

The net was dragged on the bottom for 15 minutes interval in which time a distance of about 1 mile was covered. At 65-100 ft depths, bottom temperatures during the last two weeks in July were 4-5°C, oxygen concentration 8 ppm, ph 7, and carbon dioxide 20 ppm.

Other fish caught in the same hauls included *Osmerus eperlanus mordax*, *Myoxocephalus thompsonii*, and *Pungitius pungitius*. The invertebrates, *Mysis relicta* and *Pontoporeia affinis*, were common. Of the 39 hauls made with the same net between July 12 and August 5, only 5 hauls contained lake charr. Twelve hauls between June 27 and July 11 and 43 hauls between August 19 and October 8 failed to catch any young lake charr in the deeper muddy bottom of the lake, although the other species listed continued to be present.

Morphology of alevins. Information about the locality, date of capture, and on the morphometric

[1]The senior author of this article tragically drowned in Lake Heney on the 20th of Oct. 1968.

TABLE 1. — Morphometric and meristic data and number of parr marks in lake charr alevins

Locality	Date and depth of capture	Bottom type	Average and range of total length of 10 mm groupings. No. of alevins in parentheses	Expressed as % of the total length				Rays in fins		No. of parr marks
				Head length	Depth of body in front of dorsal fin	Predorsal fin length	Preanus length	Pectoral	Pelvic	
East and west of long island in Lake Heney (75° 54′—75°57′ long., 45° 59′–46° 04′ lat.) Gatineau County, Que.	July 16 -29 , 1968; 65–110 ft.	Ooze and clay	mm 45.2 (7) 40.8–48.6	22.2 21.1–23.2	14.4 13.6–15.8	41.3 40.0–43.0	61.5 59.5–63.2	14.4 14–15	9.0 9–9	9.7 9–11
			33.1 (1)	20.1	14.2	39.6	58.6	14	9	7
West Buxton Hatchery Maine, U.S.A.[1]	Raised in the hatchery and received preserved in 1963		46.6 (4) 45.0–49.3	23.2 22.9–23.5	13.7 13.2–13.9	43.4 43.1–43.5	63.9 62.9–64.0	14.0 14–14	9.5 9–10	8.8 7–10

[1]Taken from Qadri (1964).

and meristic characters, and colour of the lake charr alevins is provided in Table 1. Morphometric measurements of body parts of alevins in mm were made according to Hubbs and Lagler (1958) and Qadri (1964) with the help of a mechanical stage. Meristic characters were counted under the stereomicroscope. These alevins were grouped into 10 mm total length intervals. The information on one group, total length 40.8-48.6 mm, is comparable in many characters to hatchery raised lake charr alevins, 45.0-49.3 mm total length.

Freshly caught lake charr alevins were bright silvery on the sides. Faint parr marks became evident only after the alevins were preserved in 5% formalin.

Food of alevins. From Lake Heney, stomachs of six alevins between the total lengths of 40.8 and 47.0 mm were examined. Five stomachs contained *Mysis relicta* and three stomachs *Pontoporeia affinis*. Their frequency of occurrence in each stomach is shown below:

Mysis relicta

1	2	2	1	2	Absent

Pontoporeia affiins

Absent	Absent	Absent	2	1	4

Eschmeyer (1956) have reported that the young-of-the-year charr fed mostly on *Mysis* in July and August in Lake Superior; *Pontoporeia* was found in the stomachs of yearling fish. In Lake Thompson, Maine, DeRoche (1969) found that during the summer months the alevins fed almost exclusively on Crustacea (Cladocera and Copepoda) except for an occasional insect.

Dr. Claude Delisle (personal communication, 1969) told me that the presence of *Mysis relicta* in Heney Lake is a range extension for the species.

Dr. D. E. McAllister of the National Museum of Natural Sciences and Dr. Claude Delisle of the Montreal Aquarium read the manuscript critically.

Literature Cited

DeRoche, Stuart E. 1969. Observations on the spawning habits and early life of lake trout. Progressive Fish — Culturist 31(2): 109-113.

Eschmeyer, Paul H. 1955. The reproduction of lake trout in southern Lake Superior. Transactions of the American Fisheries Society, 84(1954): 47-74.

Eschmeyer, Paul H. 1956. The early life history of the lake trout in Lake Superior. Michigan Department of Conservation Miscellaneous Publications No. 10: 1-31.

Hubbs, C. L., and **K. F. Lagler.** 1958. Fishes of the Great Lakes. The University of Michigan Press, Ann Arbor, 213 p.

Lagler, K. F., J. E. Bardach, and **R. R. Miller.** 1962. Ichthyology. John Wiley and Sons, Inc., New York, 545 p.

Qadri, S. U. 1964. Osteology and morphology of the genera *Cristivomer* and *Salvelinus* and their relationships with other Salmonidae. Ph.D. Thesis, Univ. Ottawa, Ottawa, Ontario, 296 p. (portions published).

Rawson, D. S., and **C. S. Elsey.** 1950. Reduction in the longnose sucker population of Pyramid Lake, Alberta, in an attempt to improve angling. Transactions of the American Fishery Society 78 (1948): 13-31.

Ricker, W. E. (Editor) 1968. Methods for assessment of fish production in fresh waters (International Biological Programme Handbook No. 3). Blackwell Scientific Publications, Oxford, 313 p.

Rupp, Robert S., and **Stuart E. DeRoche.** 1960. Use of a small otter trawl to sample deep-water fishes in Maine Lakes. Progressive Fish — Culturist 22(3): 134-137.

W. H. VAN VLIET
S. U. QADRI

Department of Biology
University of Ottawa
Ottawa, Canada
Received November 9, 1969
Accepted January 5, 1970

An Old World Race of the Whimbrel on Amherst Island, Ontario

Abstract. An Old World race of the Whimbrel (*Numenius phaeopus*) was seen at Amherst Island, Ontario, May 24, 1969. This appears to be the only inland record for North America. The validity of considering the New World and Old World forms as races rather than as distinct species is questioned.

On May 24, 1969, taking advantage of one of the first warm sunny days of the year, I went with my family and Mrs. A. E. Hughes to Amherst Island which is located in Lake Ontario, a few miles from Kingston, Ontario. At the point of land called Wemp's Point, on the southwest part of the island, we had been observing the gulls and the Turnstones (*Arenaria interpres*) and were about to depart when a large flock of shorebirds flew in. There were 130 ± 10 of them and they were Whimbrels, their uniform brown backs downcurved bills and eye stripes being noticeable. This is the largest flock of Whimbrels to be seen in the Kingston area since the days of Beaupré (Quilliam, 1964, and pers. comm.).

Almost immediately we noticed that one of the birds had a white rump and a white area which stretched a little way up its back. We watched this bird almost continuously for 15-20 minutes, with 8 × 30 binoculars, while the flock was circling back and forth between 50 and 200 yards from us. We noticed the following features about the bird. Like the others, it had a downcurved bill. It was a greyer brown than the others and paler below. Its wings were less uniformly brown than the others with the primaries darker than the secondaries. We saw no signs of streaking on the white rump, but the distance may have been too great to observe whether these were present or not. Although there was some size variation in the flock, the white rumped bird was one of the largest, if not the largest bird in the group. It frequently separated from the main flock, as if recognizing its distinctness. It called much more frequently than the other birds and its call was easily separable from the others. It had a call of 6 distinct notes, all similar in tone to each other. The call was louder and slower than that of the other Whimbrels.

After the display of aerial manoevres by the flock, 40 including the white rumped bird flew off to the west while the remaining birds landed and allowed much closer approach.

A large brown shorebird with a down-curved bill and a white rump must be either a European Curlew (*Numenius arquata*), a European race of the Whimbrel (*Numenius phaeopus phaeopus* or *Numenius phoeopus islandicus*) or possibly one of the Asiatic races. The Curlew is a much larger bird than the Whimbrel and has a two-phase call note similar to that of the Long-billed Curlew (*Numenius americanus*). The Whimbrel on the other hand is often known as the 'seven whistler' because of its call. The smaller size and the distinctive call note makes it obvious that this bird was not a European Curlew. The other distinctive feature separating the Curlew and the Whimbrel,

namely the pale stripes on the head, were not observed since the bird did not approach close enough for these to be seen. Both Mrs. Hughes and I have seen the Whimbrel in Europe and I am familiar with the call of both species. It is perhaps no more than coincidence that two more Eurasian species were seen at the same location six days earlier. These were a European Widgeon *(Anas penelope)* and a Little Gull *(Larus minutus)*.

The Old World races of the Whimbrel have been reported in North America on very few previous occasions as far as I have been able to discover. There are two specimen records of *N. p. phaeopus*, one at Jones Beach, Long Island, New York, 4 September 1912, and one at Red Bay, Labrador, 14 May 1932. There are two specimen records of *N. p. islandicus* one taken off Sale Island, Nova Scotia, 23 May 1906 and at Pistolet Bay, Newfoundland, 27 June 1943. There is a sight record of one of the European races for Cape Cod, Massachusetts, in September 1951. There are also records of the Siberian race (*N. p. variegatus*) for Alaska. It would be impossible on the basis of field observations to say which race the Amherst Island bird was. It was a large bird which suggests *islandicus* but it is of interest to note that Vaurie (1959) does not recognize that there are two distinct European races. These races are separated by the size difference but Vaurie found that Swedish specimens of *N. p. phaeopus* were also large.

The distinctness between the Old World and the New World forms of the Whimbrel in both morphology and call note causes one to question the validity of regarding the two groups as members of a single species. Todd (1963) follows the treatment of Ridgway (1919) and considers the two groups as distinct species, while at the same time recognizing that *N. p. hudsonicus* is the New World representative of the Eurasian Whimbrel.

This bird seen on Amherst Island represents, as far as I can discover, the first report of an Old World race of a Whimbrel from inland North America.

Literature Cited

Quilliam, H. L. 1964. A history of the birds of Kingston, Ontario. Privately published.

Ridgway, R. 1919. The birds of North and Middle America Pt. VIII. United States National Museum Bulletin 50 pt. 8.

Todd, V. E. C. 1963. Birds of the Labrador Peninsula and adjacent areas. University of Toronto Press.

Vaurie, C. A. 1959. Birds of the Palaearctic Fauna. H. F. and G. Witherby Ltd., London, W.C. 1.

F. COOKE

Department of Biology
Queen's University
Kingston, Ontario
Received June 18, 1969
Accepted August 20, 1969.

Distribution of Golden-Mantled Marmot in Alberta

Abstract. The golden-mantled marmot, a recent entry into southern Alberta, has extended its range northward along the St. Mary and Oldman River Systems.

Soper (1964) stated that the golden-mantled marmot, *Marmota flaviventris nosophora* Howell, was of casual occurrence and late entry into southern Alberta. The species was reported from the Milk River region (Moore, 1952) and, according to Soper (1964), occurred also in Waterton Lakes National Park. Soper (1964) described an extraordinary collection made by officers of the Fish and Wildlife Division of the Alberta Department of Lands and Forests on semiarid plains near Lake Newell in 1957.

The purpose of this note is to call attention to an apparent extension in range of the species.

The golden-mantled marmot is now fairly common along the Milk River and usually can be seen among the sandstone cliffs of Writing-on-stone Provincial Park. Locally it is known as the "rockchuck". The species has become established along the St. Mary River and the Pothole Creek, and along the Oldman River in the vicinity of Lethbridge where it appeared about 1965-66. It is known as the "yellow-bellied marmot" in the Lethbridge area but is identical in appearance to the "rockchuck" of the Milk River.

The presence of golden-mantled marmots in the Lethbridge area was brought to my attention by Mr. Frank A. Russell, a farmer with property on the St. Mary River and the Pothole Creek. About 1965 marmots established themselves in an eroded bank near Mr. Russell's farm headquarters. They were identified as belonging to the *flaviventris* group, Yellow-bellied Marmots, by Mr. Gayland

Armstrong, Wildlife Biologist, Alberta Department of Lands and Forests, Lethbridge. As mentioned above, they are identical in appearance to the marmots that frequent the sandstone cliffs along the Milk River and which were identified by personnel of the Zoology Department, University of Alberta, as *Marmota flaviventris nosophora* Howell, Golden-mantled marmot (Moore, 1952).

I venture to suggest that the species will continue to move eastward along the Oldman and South Saskatchewan Rivers.

Literature Cited

Moore, J. E. 1952. Notes on three additions to the rodent fauna of Alberta. Can. Field-Nat. *66*, 142-143.

Soper, J. D. 1964. The mammals of Alberta. Alberta Dep. Industry and Develop., Edmonton. 410 pp.

ALEX JOHNSTON

Research Station,
Canada Department of Agriculture,
Lethbridge, Alberta.
Received September 1, 1969
Accepted April 7, 1970

Barn Swallow from Cornwallis Island, N.W.T.

Abstract. An adult male Barn Swallow, *Hirundo rustica erythrogaster* taken at Resolute Bay Cornwallis Island N.W.T., 74° 43′ N, 94° 40′ W represents a record 150 miles north of any previous specimen.

On 24 June 1969, an adult male Barn Swallow, *Hirundo rustica*, was collected at Resolute Bay, Cornwallis Island, N.W.T., 74° 43′ N, 94° 40′ W, by Mr. John Geale. The bird was given to Mr. J. E. Mason of Toronto who brought it to the Royal Ontario Museum. It is now specimen No. 105507 in the collection of the Department of Ornithology. On the basis of plumage characteristics as outlined by Ridgway (1904) the bird belongs to the North American race *H. r. erythrogaster*. The bird, not in breeding condition (testes = 1 mm) and without fat, measured: wing (chord) = 115.1 mm, tail = 69.3 mm, culmen from nostril = 5.75 mm, tarsus = 13.6 mm.

This form breeds in Canada north to near the tree line, i.e. southern Yukon, western Mackenzie District, north central Saskatchewan, central Manitoba and Ontario, and southern Quebec and Labrador (Godfrey 1966). The northern-most breeding occurs in Alaska at Kobuk River, 66° 55′ N, 157° 00′ W (Bent 1942). Casual (non-breeding) records include: 30 June 1950 at Cambridge Bay, Victoria Island, N.W.T., 69° 09′ N, 105° 00′ W (Sweatman, 1951); 4 June 1964 at Arlone Lake, N.W.T., 67° 22′ N, 102° 10′ W (Ryder, 1965); 14 June 1930 on Mansel Island in Hudson Bay (Sutton, 1932) and Upernavik, Greenland, 72° 50′ N, 56° 00′ W (A.O.U. Check-list, 1957). Our specimen represents an occurrence 500 miles north of the species normal breeding range and 150 miles north of any previous record for the Western Hemisphere.

We wish to thank Mr. Geale and Mr. Mason for their interest and effort in securing this record.

Literature Cited

American Ornithologists' Union. 1957. A check-list of North American Birds. Fifth edition. Pp. 691.

Bent, A. C. 1942. Life Histories of North American Flycatchers, Larks, Swallows and their allies. U.S.N.M. Bull. 179: 1-555.

Godfrey, W. E. 1966. The Birds of Canada. Nat. Mus. of Canada Bull. 203: 1-428.

Ridgway, R. 1904. The Birds of North and Middle America. U.S.N.M. Bull. 50 (3): 1-801.

Ryder, J. P. 1965. The Barn Swallow in the Central Canadian Arctic. The Can. Field-Nat. 79(2): 155.

Sutton, G. M. 1932. Notes on a Collection of Birds from Mansel Island, Hudson Bay. The Condor 34: 41-43.

Sweatman, G. K. 1951. The Barn Swallow at Cambridge Bay, N.W.T. The Can. Field-Nat. 65(5): 184.

ROSS D. JAMES
JON C. BARLOW

Department of Ornithology
Royal Ontario Museum
100 Queens Park
Toronto 181, Ontario.
Received November 3, 1969
Accepted March 19, 1970

The First Nesting Record of the Eastern Phoebe for Grand Manan, New Brunswick

In his paper on the bird life of Grand Manan, Pettingill (1939, Proceedings of the Nova Scotian Institute of Science 19(4): 352) mentions an Eastern Phoebe, *Sayornis phoebe*, which was "undoubtedly nesting in the vicinity". However he was unable to find the nest and I have not found any other records for the species. It is of interest therefore to record that on 19 June 1967, Gerald L'Aventure owner of The Anchorage showed me one sitting on eggs in a nest on the side of one of his cabins.

C. CHANDLER ROSS

Academy of Natural Sciences
19th and Parkway
Philadelphia, Pa. 19103
Received November 20, 1968
Accepted March 20, 1969

Breeding Records of Herring Gulls in Alberta and California Gulls in Manitoba

Abstract. Herring Gulls were observed to breed farther south in Alberta than previously known and California Gulls are more common breeders in Manitoba than once thought.

HERRING GULLS — Alberta. On July 5, 1967, about 25 pairs of nesting Herring Gulls (*Larus argentatus*) were observed to intermingle completely with breeding California Gulls (*Larus californicus*) on an island (57° 27′N; 112° 37′W) in Namur Lake. Namur Lake is at the periphery of the breeding range of Herring Gulls as indicated by Godfrey (The birds of Canada, Bulletin no. 203, National Museum of Canada, 1966). On July 6, 1967, a breeding colony of about 20 pairs of Herring Gulls was observed on an island (59° 43′N; 118° 40′W) in Bistcho Lake. On May 17, 1969, a pair of Herring Gulls was observed attending a nest with three eggs among incubating California Gulls on a small island (53° 54′N; 111° 23′W) in Lower Therien Lake. Bistcho and Lower Therien Lakes are considerably south of the breeding range of Herring Gulls as shown by Godfrey.

CALIFORNIA GULLS — Manitoba. On June 4 and 5, 1969 a dozen pairs of California Gulls were observed nesting on an island (50° 49′N; 98° 37′W) in Lake Manitoba; about 200 pairs of this species nested on an island (52° 25′N; 100° 20′W) in Pelican Lake; and about six pairs of California Gulls bred on an island (53° 04′N; 100° 30′W) in Lake Winnipegosis. Herring Gulls and Ring-billed Gulls (*Larus delawarensis*) bred also on those three islands. The nest distribution of California Gulls was separate from that of the Ring-billed Gulls but overlapped that of the Herring Gulls to some extent. Although a dozen lake islands west of Lake Manitoba and north and west of Lake Winnipegosis were visited in Manitoba in 1969, California Gulls were not observed to breed there. Moynihan (The Auk 75 : 453-454, 1956) reported a pair of California Gulls nesting at Dog Lake in 1954. He believed that to be the first breeding record of this species for the province. From the above observations it appears that California Gulls are more common breeders in southwest Manitoba than once thought.

KEES VERMEER

Canadian Wildlife Service
515 Centennial Building
Edmonton, Alberta
Received August 20, 1969
Accepted November 6, 1969

Loggerhead Shrike Breeding in Nova Scotia

Abstract. The discovery of a nesting pair of Loggerhead Shrikes (*Lanius ludovicianus*) at Petit Etang, one mile north of Cheticamp, Cape Breton Island, constitutes the first definite breeding record for Nova Scotia and the most easterly for North America. Three young were successfully reared and left the nest on June 29, 1969.

The discovery of a nesting pair of Loggerhead Shrikes (*Lanius ludovicianus*) at Petit Etang, one mile north of Cheticamp, Inverness County, constitutes the first definite breeding record of this species for Nova Scotia and the most easterly for North America. The nest, which was composed of weed stems, coarse grasses, rags, and bits of string, was situated at a height of five and one-half feet

in a ten-foot thornbush (*Crataegus* sp.), one of several dozen forming a copse dividing abandoned hayfields.

It is not known when nesting began but the three young left the nest on June 29, 1969, and the family group was seen in the immediate environs of the copse until July 28. One fledgling was killed on the highway on July 5, a wing of which was salvaged from the badly mutilated body.

The pair was first seen in the vicinity of the thorn copse on April 29 when field observations were begun. They were exceptionally tame and frequently alighted on the ground, in pursuit of an insect, within a few feet of the observer, providing excellent opportunities to carefully observe the diagnostic features of this species. The extension of the black facial mask across the lower forehead and the lack of barring on the abdomen definitely established these birds as Loggerheads rather than Northern Shrikes (*Lanius excubitor*), the only other species with which confusion is possible.

R. W. Tufts (The Birds of Nova Scotia, 1962) states that the Loggerhead is rare in Nova Scotia with only one specimen record for the Province and less than a dozen sight observations, including an adult seen at Chipman's Corner, Kings County, which behaved as if it were nesting. There is only one previous sight record for Cape Breton; one was noted by John and Gwen Lunn at Louisburg on April 18, 1965 (A. M. Bagg and Ruth Emery, *Audubon Field-Notes* 19 (5): 527).

AUSTIN W. CAMERON

Redpath Museum, McGill University,
Montreal, Canada.
Received July, 1969
Accepted November 3, 1969

A Golden Eagle Harassing Bighorn Sheep

Abstract. On September 29, 1968, an immature Golden Eagle, *Aquila chrysaetos*, was observed harassing an adult Bighorn ram, *Ovis canadensis*, by making repeated dives at the animal's head. At no time was actual contact observed.

On September 29, 1968, George Elder, Seasonal Naturalist, and I observed an incident of severe harassment of a bighorn sheep, *Ovis canadensis* by a Golden Eagle, *Aquila chrysaetos*.

At mid day we were observing a group of 15 mature bighorn rams on the Palliser Range in Banff National Park through binoculars. The sheep were grazing on an open slope above timberline about one quarter mile from our position and about one thousand feet higher.

Two mature Golden Eagles appeared from the north and circled high over the sheep. The eagles then descended and made several low passes over the animals before flying south and on down the valley. The sheep appeared totally unconcerned and continued to feed throughout.

A short while later, a third eagle appeared from the same direction. This bird, an immature, also swept low over the sheep several times with no apparent reaction. The eagle then selected one ram of about five years old and began making repeated dives at the back of the animal's head.

These dives were launched from a height of 25 to 75 feet and terminated within a foot or two of the animal. After several passes the ram started running erratically downhill toward the observers and the timber. The eagle continued its harassment and dove repeatedly toward the back of the sheep's head, sometimes coming within a few inches. At no time was actual contact observed.

The last pass was made within 50 yards of the observers. The eagle then apparently saw us and broke off the attack. Shortly after, the ram reached the fringe of the timber and stopped under the first tree it came to.

It is not known if the eagle was actually trying to kill the sheep or simply harassing it.

It has been shown that Columbian ground squirrels, *Citellus columbianus*, and other rodents, are the mainstay of the Golden Eagle's diet in the Canadian Rockies. There is little evidence of predation on ungulates either young or adult. By late September few ground squirrels are active and the eagle could have therefore been very hungry. This, coupled with the fact that the bird was immature and therefore inexperienced could have driven it to attack a prey of this size.

ERNEST B. CUNNINGHAM

Formerly
Chief Park Naturalist,
Banff National Park.
Received March 10, 1969
Accepted March 17, 1970

News and Comment

The History and Activities of The Canadian Wildlife Federation

MAN's journey to the Moon has brought far more than Moon fragments back to the Earth: It has brought new attitudes as well. We have become familiar with the bleak lunar landscapes so vividly contrasted by the living Earth, hanging alone and jewel-like in an empty sky. Now we can more easily comprehend the Earth for what it is, a far-travelling spaceship supplied with a precious and finite store of water, oxygen and nutrients to be cycled and recycled by its unique assemblage of plant, animal and human passengers.

But the last few years have given us another view of the Earth, too. Americans learned recently that clean air is no longer available in their nation. The last vestige of it disappeared some six years ago when airborne pollutants reached Flagstaff, Arizona from Los Angeles, California. In fact, Apollo X astronauts located Los Angeles with ease from 25,000 miles in space, not by looking for prominent geographical features nor for the lighted city at night, but simply by observing the brown miasma of smog which so commonly shrouds that city. Adventurer Thor Heyerdahl reported after his ill-fated attempt to cross the Atlantic Ocean on a papyrus raft that he and his crew found the water in mid-Atlantic so filthy that they could not bear to dip their toothbrushes into it. DDT and Dieldrin have been found in Canadian polar bears and Antarctic penguins. Black snows have fallen on Norway. There have been acidic rains in Sweden. And fish off the Atlantic coast of North America are suffering damage to their fins, caused by excessive growth of fungi in the sewage-enriched sea.

There can be no doubt that the human passengers of Earth have grossly neglected the welfare of their planet. From the errors of Babylonians, who turned their verdant land into a desert, to the 19th Century slaughter of the most numerous bird the world has ever seen, the passenger pigeon, to the 20th Century tragedy of DDT, men have not had the benefit of an ecological conscience. They have not understood their incredibly great power to maim and destroy the natural systems of the Earth.

Unfortunately, that situation has changed little. By and large, Canadians still go about their daily business unhampered by restrictions imposed by an ecological conscience, for the fact is that although most Canadians have heard the word ecology, they have not learned what it means to their total welfare.

This belief is borne out in the lack of regulations which leads to misfortunes such as that which overtook the tanker Arrow when it unceremoniously met with Cereberus Rock in Chedabucto Bay. Canada's lack of an ecological conscience is evident in the schemes to drain Canadian rivers and lakes southward to American cities and farms, and in the current uncontrolled rush of oil and mineral exploration in the fragile north. There is no evidence of ecologically oriented planning in the fact that more and more Canadians find themselves living in what an inventive Californian has termed "slurbs", nor in the fact that pollution is growing at a faster rate than we are controlling it. This is the milieu into which the Canadian Wildlife Federation was born almost eight years ago, as a direct result of the Resources for Tomorrow Conference held in Montreal in the autumn of 1961.

Representatives of provincial sportsmens' organizations meeting in Montreal discussed the urgent need for a national organization which could provide leadership for a broad-ranging educational program in wildlife and resource management. Their deliberation resulted in the formation of a working committee, and on November 2, 1962, the Canadian Wildlife Federation was established at Ottawa and soon received its Dominion Charter as a non-profit organization and "charitable" status under the Income Tax act.

All ten provincial sportsmens' organizations, representing approximately 175,000 anglers and hunters, are now affiliated with the Canadian Wildlife Federation. These groups are the Wildlife Federations of Newfoundland-Labrador, Nova Scotia, New Brunswick, Quebec, Manitoba, Saskatchewan, and British Columbia; the Fish and Game Associations of Alberta and Prince Edward Island; and the Ontario Federation of Anglers and Hunters. In addition, three national organizations—Ducks Unlimited (Canada), the Canadian Audubon Society, and the Canadian Society of Wildlife and Fishery Biologists—participate in shaping conservation policies and programs of the Federation, an arrangement which ensures liaison in working toward common goals.

The prime objective of the Canadian Wildlife Federation is stated explicitly in its Letters Patent: "To foster understanding of natural processes so that people may live in harmony with the land, using and husbanding its renewable natural resources in a manner which maintains its productivity and its beauty for the long-term benefit and enrichment of society." This objective has imposed on the Canadian Wildlife Federation a variety of tasks, nearly all of them oriented toward educating Canadians in ecological concepts in order that they might be better prepared to make decisions concerning the fate of their natural resources.

At the request of the federal and provincial governments, one of the continuing tasks of the Canadian Wildlife Federation has been the coordination of National Wildlife Week programs. National Wildlife Week is an annual observance declared by an Act of Parliament in 1947. It is the week which contains the date April 10, the birthday of the late Jack Miner who won worldwide renown as one of Canada's early naturalists.

From simple beginnings, the Canadian Wildlife Federation has gradually expanded its National Wildlife Week program. Today, posters, educational booklets, and classroom lessons are distributed through provincial resource departments to primary and secondary schools throughout Canada. The general public is reached through news and editorial material supplied to news media, through one-minute colour films distributed to all television stations in Canada, and through programs initiated by provincial and local sportsmen's organizations.

In the seven years that the Canadian Wildlife Federation has coordinated National Wildlife Week, its themes have concerned outdoor recreation, pesticides, conservation in Canada's second century, wildlife habitat, land-use planning and water pollution. The theme of this year's program, "Endangered Wildlife in Canada", dealt with the

plights facing 66 Canadian species and subspecies, 65 of which are endangered by human activity. Throughout each of its programs, the Federation has attempted to give an ecological orientation to the subjects at hand, always equating human welfare to the welfare of natural systems.

But the National Wildlife Week programs, extensive though they are, cannot possibly impart basic ecological concepts to Canadians generally. Ecology is far too complex a subject to lend itself to "one-shot" instruction. A better way to impart ecological thought patterns was found in the Federation's Centennial Project.

The Centennial Project, "Conservation Education in Canadian Schools", is designed to foster ecological understanding among students progressing through elementary and secondary school programs. Initially the project involved contacts with departments of education and visits to teacher-training institutions and teachers' federations. It soon became evident that conservation education was so poorly served that major emphasis had to be given to the Centennial Project far beyond the centennial year.

Although lack of attention to ecology is apparent in both elementary and secondary levels of education, the correction of this inadequacy requires a different approach on each level. At the secondary level, where subject areas are more clearly defined and where teachers have advanced training in their subject field, giving greater emphasis to ecology is largely a matter of adjusting curricula. The Federation is continuing to discuss this matter with the branches, committees, and consultants who have responsibility for recommending or implementing such changes. But at the elementary level, where curricula already include material relating to natural science and to uses of natural resources such as forestry, fisheries, and agriculture, the major requirement is for teachers to receive training in the fundamentals of ecology. Progress toward including ecological studies in the training of teachers has been minimal. For those teachers already practicing their profession, opportunities for receiving formal training in ecology are almost nonexistent. Clearly, there is an urgent need to establish schools at which practicing teachers and student teachers can receive training which will fit them for teaching the ecological viewpoint and participating in education in the out-of-doors in order that their students might gain understanding of the environment on which they are dependent.

The Canadian Wildlife Federation hopes to cooperate in the establishment of schools of natural history at widely separated field locations in Canada; negotiations are continuing with several universities that may be able to provide facilities and staff for these schools. This summer, the University of Calgary will offer a pilot course, called "Ecology in Outdoor Education" at its Environmental Sciences Centre at Kananaskis.

As the schools of natural history are established, it is hoped that they will be used for six-week summer courses for elementary teachers; three-week courses starting early in September for student teachers and teachers taking in-service training; weekend workshops for teachers; and visits by school classes on a daily or a "live-in" basis, depending on the facilities at the school. It is hoped that courses for teachers would carry university credits and would qualify the teacher for certification as a specialist in outdoor education.

Another of the continuing, and very successful, activities of the Canadian Wildlife Federation is publication of its quarterly WILDLIFE NEWS, a bilingual commentary on resource issues which is mailed to more than 4,000 individuals, including members of the Federation, M.P.'s and M.L.A.'s, and to all Canadian newspapers. Wildlife News is frequently quoted and favourably commented upon by the nation's news media; recent issues have contained articles on detergent pollution, the necessity for population planning, the Southern Indian Lake controversy, drainage programs in the west, persistent pesticides, and destruction of northern landscapes, as well as occasional reviews of resource-oriented books.

While the foregoing activities of the Canadian Wildlife Federation consume much of its time, it is nevertheless deeply involved in the discussion of current resource questions with the federal government and other conservation organizations.

In March of this year it presented a brief on the Canada Water Act to the House of Commons Standing Committee on National Resources and Public Works, suggesting among other points that the federal government has, in existing legislation, historical precedents to follow in increasing its activity in pollution control; that without commitment of the federal treasury to the control of pollution, the Canada Water Act would be largely ineffective; and that establishment of national water quality standards is necessary if regional competition for industry is to be avoided and if

those areas in Canada most in need of pollution control are to receive it.

Also in March, the Wildlife Federation released a statement to the press calling for a partial four-year moratorium on northern oil and mineral exploration in order to permit the completion of current ecological studies which might point the way to development of less-harmful methods of resource exploitation. The statement and subsequent meetings with officials of the Department of Indian Affairs and Northern Development led to the establishment of a group which will study damage to northern ecosystems and make recommendations to the federal government concerning a moratorium.

The Canadian Wildlife Federation is still far from its goal of bringing an understanding of natural processes to all Canadians. It is hoped that its program can become broader, eventually including publication of a conservation handbook and pamphlets on Canada's wildlife, expanded National Wildlife Week programs, and grants and scholarships for university students studying the natural sciences. These are long-range goals, however, contingent on money and membership which the Federation does not now have.

In the meantime, with each contact with government, with each new issue of WILDLIFE NEWS, with each year's National Wildlife Week, and with continuing efforts to involve Canadian educators in comprehensive resource education, the time comes nearer when Canadians will know how to live in harmony with their land. The question is whether that time can be reached before the Spaceship Earth becomes derelict.

BOB INGRAHAM

Conservation Editor,
Canadian Wildlife Federation,
1419 Carling Avenue,
Ottawa, Canada
March, 1970.

(**Editor's Note:** The Canadian Wildlife Federation, like so many similar organizations, has been throughout its existence chronically short of money. As noted in the foregoing article, its many invaluable programs are restricted by this fact. Anyone wishing to become a member of the Canadian Wildlife Federation may do so by contacting the Federation's offices at 1419 Carling Avenue, Ottawa 3, Canada. Associate Memberships are available at $5.00 per year; Sustaining Memberships are available from $25.00 per year.)

Zero Population Growth

Zero Population Growth is a new volunteer organization which advocates that all measures be taken immediately to stem the tide of world population growth. ZPG began in Connecticut in 1968. Dr. Paul Erlich, author of *The Population Bomb*, an ecologist and professor in the Department of Biological Sciences at Stanford University, Stanford California, is the honorary President. The national U.S. headquarters is now located at Los Altos, California (address: 367 State Street, Los Altos, California 94022). To date nearly 150 chapters have been formed in the United States with a membership over 15,000 and growing at the rate of nearly 1,000 per week. Fifty new chapters were formed in the month of April alone!! ZPG publishes the ZERO POPULATION GROWTH NATIONAL REPORTER, a monthly magazine with a circulation of nearly 20,000.

Five chapters now exist in Canada. These are at Toronto, Hamilton-Burlington, Tofino, B.C., Vancouver, B.C., and Fredericton, N.B. The Toronto Chapter with a current membership of 220, began late in January, 1970 and without extensive membership or publicity drives has already received good coverage by articles in the local newspapers and by radio and television interviews with founders of the chapter. Dr. D. M. Power of the Royal Ontario Museum is Chairman and Dr. R. C. Plowright of the University of Toronto is Secretary.

The goal of ZPG is to stabilize population growth in North America by 1980. ZPG believes that there is now an overpopulation crisis and that if number of births is not decreased to equal the number of deaths much of the world will face famine and social disruption. In the developed nations where the impact of man on the ecosystem in terms of polluting the environment and in food, mineral and resource use per capita is greater than in developing countries, unchecked population growth will drastically alter our quality of life. ZPG believes that overpopulation is now resulting in an accelerating erosion of the fundamental rights and freedoms of mankind. ZPG believes that Canada has a responsibility to herself and to other nations on our rapidly changing planet. Activities will involve pressing for education and publicity concerning the relationship between man and his environment, and our responsibility to present and future generations. ZPG is pushing for the two-child family, or adoption for couples

desiring larger families. ZPG hopes to encourage the government to (1) take a positive stand on the need for population stability, (2) help develop and publicize simple and effective contraceptive techniques, and (3) ensure the right of voluntary sterilization and abortion regardless of age, marital status, or financial means. Toward this end ZPG is gathering data on the relation between population growth and of quality life that considers Canadian population increase in relation to food, land, mineral resources and educational and public facilities. ZPG has also prepared a unit discussing human ecology and population for secondary school use. The ZPG Education Committee has just published its own Birth Control Handbook.

Membership fee is $2.00 for students and $7.50 for families. All members receive the ZPG NATIONAL REPORTER. Membership forms or further information may be obtained by contacting Dr. D. M. Power (Royal Ontario Museum, Toronto, Ontario; phone 416 928-8822) or Dr. R. C. Plowright (Department of Zoology, University of Toronto, Toronto, Ontario; phone 416 928-6156) at the local chapter office.

D. M. POWER

International Biological Program — Conservation of Terrestrial Communities (IBP-CT)

The objectives of IBP-CT in Canada are to locate examples of all major ecosystems in Canada and work toward their protection as ecological reserves. Both natural and man-modified systems are eligible for protection, but greatest emphasis is being placed on natural ones. National and Provincial Parks and other forms of publicly held land are being surveyed, but major emphasis is again being placed on finding entirely new areas. For the most part the subcommittee is looking at Crown lands, but privately owned land will also receive consideration. As areas are examined a standard Check Sheet is completed. One copy of the Check Sheet is forwarded to Monk's Wood (United Kingdom) for deposit in the International Registry.

The organization of IBP-CT is as follows. Canada has been divided into ten regions, each with two co-chairmen and a consulting panel of variable size. Regions 1 - 6 each coincide with a Province proceeding eastward from British Columbia to Quebec. Region 7 encompasses the three Maritime Provinces and region 8 equals Newfoundland and Labrador. Regions 9 and 10 cover the two northern territories, but the subdivision is based on the treeline rather than on a political boundary. Thus, region 9 covers tundra and region 10 the adjacent taiga north of 60°.

At least one of the two co-chairmen must be affiliated with a University in order to be eligible for a grant from the National Research Council through CCIBP. The other co-chairman may be a government employee. In most regions the co-chairmen are one botanist and one zoologist.

The work of IBP-CT has received the blessing, in principle, of the Canadian Council of Resource Ministers and contacts have been made with CCRM at both National and Provincial levels. Several federal government departments are assisting in the work of the subcommittee in a variety of ways. Most frequently, personnel travelling in the north are permitted to devote a portion of their time to description of a potential ecological reserve. The Canadian Wildlife Service and the Canada Department of Agriculture have contributed in this way. In most provinces liaison has been achieved with one or more departments. Natural Areas Committees of the Provincial Government are active in Ontario and Alberta for example. There is also liaison with the Nature Conservancy of Canada.

Consulting panels have contacted colleagues and often, also, amateur naturalists in most regions in order to draw up an initial list of potential reserves. The lists are then studied by the panel and plans are drawn to complete check sheets on the most promising areas. Panels would be glad to receive additional candidate areas. If readers of the CANADIAN FIELD-NATURALIST do not know who to contact in their region, suggestions may be sent to the writer.

Progress has been uneven across the country for a variety of reasons. Some panels started earlier than others. Some have had more enthusiastic support from provincial officials. Some, like the tundra panel, simply have too great an area to cover with their limited funds. However, progress is apparent on all fronts. In 1970, for the first time, the subcommittee has a budget that allows field work in all regions and we are looking forward to a productive summer. A simple listing of numbers of areas surveyed by regions would not

be very informative, and a detailed listing would be both premature and beyond the scope of this note.

From the outset two major problems have been apparent. One of these concerns management of the ecological reserves after the official end of IBP in 1972. The question of some sort of successor to IBP is still open and no firm recommendations have been made on this point.

The second question is — what kind of legal protection will the reserves enjoy? Since all ten provinces and the federal government will be involved, the legal protection, if any, could be chaotic. Fortunately, however, Professor A. R. Thompson and some of his colleagues at the University of British Columbia are undertaking a study of the legal background for ecological reserves. The objective of their research is to draw up a set of guidelines for legal draftsmen with the ultimate hope that each of the senior governments will agree to provide legal protection for the reserves in their care and that there will be a uniform philosophy behind each of the separate pieces of legislation.

WILLIAM A. FULLER,

Chairman, IBP-CT
Department of Zoology
University of Alberta
Edmonton, Alberta

Provincial Organization of Naturalists Formed in Alberta

At an inaugural meeting in Calgary on Saturday, April 4th, 1970, representatives from six naturalist societies and clubs in the Province approved the formation of a FEDERATION OF ALBERTA NATURALISTS. This move has been made as Alberta was the only western province that lacked a provincial organization.

The Federation hopes to encourage among Albertans an increase in their knowledge of natural history and understanding of ecological processes; to promote an exchange of information between natural history clubs in Alberta, and to foster the formation of additional clubs and societies in areas of the Province not presently served by naturalist groups.

The Federation will promote the establishment of natural areas and nature reserves to conserve and protect species, communities or other features of interest and will organize or coordinate symposia, conferences, field meetings, nature camps and research.

The Federation will also provide the naturalists of Alberta with a Provincial organization to give a lead in relating their views on the conservation of the natural environment to federal, provincial and local governments, to other concerned bodies and institutions, and to the citizens of the Province.

The founding clubs and societies of the Federation are the Alberta Natural History Society (Red Deer), Bow Valley Naturalists (Banff), Calgary Field Naturalists' Society, Edmonton Bird Club, Edmonton Natural History Club and the Lethbridge Natural History Society. Directors appointed by these founding groups will meet later in the year to approve the Objects and Bylaws of the Federation, and to discuss and plan the activities of the Federation.

FEDERATION OF ALBERTA NATURALISTS
c/o Box 981, Calgary 2, Alta.

Davidsonia

A new, quarterly journal is to be published by the Botanical Garden, University of British Columbia, Vancouver. The brief introduction by the Director of the Garden, Dr. Roy L. Taylor, suggests that the general purpose of the new journal will be to help the garden and its staff promote a greater public awareness and appreciation of plants in relation to man. The journal should provide a much needed outlet for the publication of Canadian west coast gardening lore and serve as a publication outlet for the garden.

The name of the journal derives from Professor John Davidson who participated in many botanical surveys of British Columbia early this century, who served on the botany staff at the University of British Columbia and who was founder of the Vancouver Natural History Society.

The first issue contains 8 pages and carries an interesting account and illustration of *Cornus nuttallii*, the Pacific or Western Flowering Dogwood, which is the floral emblem of British Columbia. The issue also carries an account of the renovation of the Rose Garden and some Botanical Garden News and Notes. Annual subscription to DAVIDSONIA is $4.00 and orders should be addressed to the Director.

Letters

An Ecologist's View of National Park Operation and Management

In retrospect there are perhaps two things that impress me most about my years of employment with the National Park Service.

First — It is an organization charged with a conservation responsibility of the highest order. Yet, there are few professionally trained conservationists — I believe most National Park employees are conservationists to a degree. Rather I said there were few conservationists with professional or formal training in conservation. The difference is important. The difference between a layman with an interest in conservation and a person with professional training in conservation is as great as the difference between an amateur mechanic and an automotive engineer. Interest alone does not produce expertise.

Second — It is an organization who's primary function and responsibility is the preservation and management of ecosystems. Yet, it is an organization almost totally devoid of ecologists or people with ecological training.

It would be interesting to see just how many of the senior supervisory and administrative staff in the Parks could even define Ecology.

This is the great paradox of the National Park Service and it has existed through the years. It is perhaps the most important single reason for the contradictory position in which the Parks often find themselves. In essence there has been a general lack of ecological thinking or understanding in the Operation, Management, and Development of the Parks.

Generally speaking the Parks have been, and still are being, managed by people with purely administrative or developmental oriented type backgrounds.

The result has been that the Parks have developed or have evolved a dual image or split personality. The first Park image is the Park of the mountains, forests, wildlife — in effect, the ecosystems.

The second image is the Park consisting of the highways, townsites, campgrounds, ski areas, etc. — in effect, the developments.

For the greater part of their existence the last park image has dominated Government thinking and action. In other words, the Parks have not been managed for the ecosystems, rather they have been managed for the developments. The ecosystems have merely formed a colorful backdrop for the developments.

The lack of ecological thinking becomes obvious when one looks at the developments that have or will be undertaken in the Parks. In many cases, development was recommended or carried out simply because it was possible from an engineering point of view. In no instance that I know of have serious ecological inventories and studies intentionally preceded development. Fortunately there have been studies carried out which have accidentally preceded development. Nelson's work on the Red Deer River Valley being an example.

In effect, development has often been undertaken or recommended because it was possible, not because it was needed, desirable, or in the best interests of the Park.

Situations where development has proven compatible to Park purposes have often been more accidental than intentional.

To my knowledge, development has never been prevented for purely ecological or scientific reasons. It has on occasion been curtailed because "it was not in keeping with park purpose". There is an important difference.

There are many examples that could be cited here. Perhaps the most noteworthy that you may be familiar with, are the proposed Cascade-Red Deer-Pipestone scenic highway, Maligne Lake Road in Jasper, proposed extension of the Yoho Valley road, and even the location of the Trans-Canada Highway in the Vermilion Lakes area of Banff through a bighorn sheep winter range.

There is little doubt that the integrity of the Parks has suffered greatly in the past because of the lack of ecological understanding. In fact it is possible that most of the mistakes that have been made in National Parks can be traced to this basic reason.

Many of these mistakes were probably not intentional and the action at the time was carried out with good intent. However good the intention, the action was often wrong simply because the people involved did not comprehend the ultimate effect of their action. In other words, mistakes were, and are, often made in ignorance.

A classic example of this in Banff was the use of a bulldozer to build a trail across the Alpine

Tundra in the Ptarmigan Lake — Baker Lake area. While the intention was good, the people involved simply did not comprehend the fragile nature of the alpine plant communities. The resulting damage will be visible 500 years from now.

Another example of unintentional and in fact almost accidental impairment of park values is the existing Cascade Fire Road. The road was initially built as a road for fire protection. Personally, I question whether or not any road can really afford protection from fire and I suspect this motive is a guise to merely get and spend money. Because of the emotions involved it is very easy to get money for any so called fire protection measures. The National Park Service is not the only organization to have used this method to good effect. The Alberta Forest Service has used it to great success and as a consequence, there is now a road up virtually every major mountain valley south of Hinton.

In any event, the Cascade road was initially built for fire protection and to provide access to the Ya Ha Tinda Ranch. Over the years, it has been kept closed to the public on the grounds that it was not safe for public travel. Yet while keeping the public out of the area, the Department periodically spent considerable sums of money to upgrade the road. The money was sometimes spent, not because the road needed upgrading, but rather, I suspect, to keep men employed and on payroll.

As a result the road has now been upgraded to the point where there is probably no justification for excluding the general public. The standard of the road certainly far exceeds that required for fire protection and access to the Ya Ha Tinda. The effect has been that the wilderness heart of Banff National Park has been split apart, not by design, intent or reason, rather by accident and short sightedness.

Most of the other fire trails and roads in Banff have a similar history. The justification of any fire roads in National Parks in the age of helicopters must be seriously questioned.

Throughout the years, the Parks have been the Government "Poor Boy" in so far as funds are concerned. In retrospect, perhaps this has been the only salvation of the Parks. If the National Parks had been given unlimited funds, there might now be a road up every valley and to the top of every mountain. Perhaps we should thank God for Austerity.

The zoning of the Parks in the Master Planning program was also largely carried out without ecological considerations. The zone boundaries are often physiographic boundaries — or boundaries of convenience. The areas designated wilderness are geographical wildernesses, not biological or ecological wildernesses. Basically what has happened is that those areas most suitable for development were zoned for development. The areas least suitable for development were zoned wilderness.

Thus great areas of wilderness were set aside to supposedly insure the preservation, among other things, of grizzly bears and other wilderness forms of wildlife. This was done without even knowing the habitat requirements of the grizzly, or where the areas of grizzly concentration were. It is probable that some of the areas zoned for development in Banff, Jasper, and Yoho are also the best grizzly habitat in the respective Parks. Survival of the grizzly depends on maintaining large areas of his habitat in a wilderness state. If his habitat is developed or opened to large numbers of people, the grizzly will certainly vanish.

If grizzly habitat has been fortunate enough to be zoned as wilderness in the Mountain Parks, it will have been accidental — not intentional.

It will be interesting to see the final zoning which is to appear in the Park Master Plans for the Mountain Parks. Groups such as ours would do well to have a critical look.

The lack of ecological understanding in Parks' operation and management has in the past resulted in many violations of the very basic principles and purposes for which Parks were established. It is probable that the National Parks and not private enterprise has been the greatest violator of Park principles. In the Mountain Parks, the worst examples of Park abuse and misuse invariably seem to be Park sponsored or condoned activities. This double standard has been one of the main reasons for the poor public image the National Parks suffers from and for the gap between the Park and Park residents.

The National Parks Service "forked tongue" approach to conservation can perhaps best be summarized by the following situations which exist in Banff and Jasper.

In both Parks vast sums of money have been, are now, or will be spent to upgrade and improve the access roads to the major ski areas (Marmot Basin, Temple-Whitehorn, Sunshine). Yet the townsites of both Parks lack even primary sewage treatment plants. Both still dump raw sewage into major rivers — a violation of the National Parks Act, by the way.

In addition neither Park has developed an adequate garbage handling and disposal program.

Normal urban garbage handling procedures and costs are not applicable in National Parks because of the attraction to animals.

The situation is epitomized at Lake Louise. On one side of the valley is a modern, very expensive access road and parking lot complex for the ski area. Directly across the valley is the Lake Louise dump. The dump is poorly located, primative, totally inadequate, and an eye sore. It may be the worst example of garbage handling in any Park. In addition, grizzly bears frequent the dump. The bears, plus the large numbers of people in the Lake Louise area are equivalent to a stick of dynamite with the fuse lit. It will be sheet luck if there is not a grizzly incident at Lake Louise. There are really no animal problems in the Parks — only garbage problems.

Conservationists must seriously question the National Park Service's sense of priorities.

Perhaps there is little need to dwell on this point further unless you care to argue the basic points. I can summarize my thoughts to this point as follows:

First. The preservation of ecosystems is the essential justification for the establishment and existence of the National Parks. The flora, fauna, mountains, and physiography are the only things of real value in the Parks. All developments, no matter how essential, have a negative value. Perhaps I should clarify this point further, I am not opposed to developments. A certain amount are required if people are to see and enjoy the Park. However, I still contend that *all* development detracts from the total value of the real Park. The real Park — the forests, wildlife, and mountains — cannot and does not benefit from development.

Second. The Parks have suffered greatly in the past because of a lack of ecological understanding in their management, operation, and development.

Third. This lack of ecological understanding has been primarily caused by a lack of personnel in decision making positions with ecological or conservation type backgrounds. Action is, after all, the result of individual thinking. I am certain it is as difficult for an architect or business administration graduate or mathematician to think like an ecologist as it is for an ecologist to think like an architect, mathematician or business graduate. It would be unthinkable to hire a biologist to design and build a bridge. Yet people with all sorts of non-related backgrounds have been given the responsibility of administering the ecological properties of the Park.

Fourth. It logically follows that the Parks probably cannot survive in the future as intended unless they are managed from the ecological point of view. Since action is the result of individual thinking, this type of management can only be achieved by hiring people with appropriate backgrounds. As with any organization and program, men are the key.

This brings us up to the present. What then are the future prospects of the National Park Service hiring men with Ecological and Professional Conservation type backgrounds in decision making positions.

Personally, I see little to be optimistic about. Frankly, there just does not seem to be a place for a Biologist or Ecologist at decision making levels.

At the present time both Park Naturalists, who were originally hired to fill an ecological role and who are presently the only ecologically trained people in the Park, and Park Warden Service, who in the future may hire professional biologists and ecologists are related to the third or fourth echelon in the Park organization. Both have suffered organizational demotions which puts them a full step below other professional and senior administrative staff within the Park and virtually at the level of blue collar workers. In practice, both may be pretty well out of the action in so far as influencing major decisions are concerned. In addition, the Park Naturalist, who at the present time, is usually the only ecologically trained person in the Park, is no longer permitted to function as a professional ecologist. The role of the Park Naturalist has been reduced to that of a pure interpreter — whatever that is — and his actual duties vary with administrations. Unfortunately he is often looked upon merely as a glorified Public Relations man or even an entertainer. I personally feel he has a much more important role to play.

It is unlikely that the National Park Service can hire and retain competent professional Biologists or Ecologists until such men are recognized and treated as professionals.

Bli Ginzberg, well known economist, pinpointed the problem in a recent lecture on Manpower Planning at the University of Toronto. Dr. Ginzberg lists four critical areas in manpower planning and utilization. Two of these four essential points are now being violated by the National Parks Service in so far as the handling of its professional biological staff is concerned:

> "First, managers will have to adjust from dealing with less educated and less trained people to

large numbers of graduates with both baccalaureate and Master's degrees. They cannot continue the same personnel practices which they have followed in the past.

"Since an educated person has made a large investment in this own development, he wants opportunity for further growth and development. Unless the personnel managers understand this, they will confront large numbers of young people who are disgruntled . . .

"The third challenge relates to the professional man in large organizations. *The first point is that a professional makes a commitment initially not to his employer but to his discipline.* During his long education he becomes an engineer, an economist, a physicist. Only later does he become an employee. In general, he has developed a set of commitments, a set of values, which govern his relationships to society. This means that employers cannot hire professionals in the same manner as they hire blue collar workers.

"Another critical issue is that professionals are often threatened by obsolescence. A man who spends many years becoming a chemist or an engineer does not want to be assigned to work which will prevent his staying abreast of his field.

"Another aspect of professionalism is that however potent nationalism may be, professionalism is stronger. Hence professionals tend to follow job opportunities wherever they are. They will leave England for Canada but if they do not find work in Canada they will move on to the United States; and if they do not find a good job in the United States they will move elsewhere. *A serious professional wants to work in accordance with his competences and his knowledge.*

Another reason which causes me to be pessimistic about the future of ecological and biological thinking in the National Parks Service is the present *management binge* which the National Parks Service is now on. The Parks are apparently to be run as efficient businesses and all senior personnel are to become business managers of sorts. The Park Manager of the future appears to be possibly a Business Administration graduate who begins his career as a junior administrator in Ottawa.

The business approach may have its merits from a dollar point of view. However, I would also like to point out that the enormous environmental problems which man now faces — such as pollution, pesticides, and ever expanding pavement. These problems which now threaten the very existence of life on earth, are the result of efficient business management and engineering of the world's ecosystems. Maybe its time to give the so-called "bug boys" and "bird watchers" a chance. It is unlikely they could do any worse.

ERNEST B. CUNNINGHAM

Lethbridge Community College,
Lethbridge, Alberta.

Reviews

The Costs of Economic Growth*

By E. J. Mishan. London, England 1967. 190 pp. $6.50.

Pollution Property and Prices*

By J. H. Dales. Toronto 1968. 111 pp. $2.50.

The first course in economics traditionally begins with a laboured discussion of the differences between free goods and economic goods. A free good is one which has no market price; unlimited use by any one party does not create scarcity nor does it deny use of that good to anyone else. Air and water are usually singled out as examples of free goods. Although they have value they are not characterized by scarcity. Thus there is no allocation problem attached to their use.

Over time, however, forces have been at work on both the supply and demand of free goods such as air and water. In the case of fresh water, the demand for clean water has risen as population has increased while the supply of clean water has decreased as it has increasingly been used for industrial uses. Fresh, clean water has now become an economic good; to its pre-existing condition of value we now add scarcity. Scarcity plus value are the two main criteria for determining that a good is economic in nature and must be rationed or allocated. Historically the price system has been employed as a method of rationing or allocating scarce goods among competing uses or competing users.

The question therefore becomes: How to allocate fresh water? Which of the competing uses should be favoured: swimming, fishing, boating, human consumption, industrial uses? At this juncture economists suggest the use of a cost-benefit analysis to determine how the existing resource should be best used (i.e., where utility can be maximized).

Cost-benefit analysis is, however, increasingly being questioned: the prices that are imputed to an activity are usually very subjective (e.g., the value of a day at the beach). Consequently cost-benefit analysis in many cases can be employed to "prove" the necessity for quite contrary and contradictory courses of action. Two analysts setting out to achieve different goals can both claim to have used cost-benefit analysis as their justification for pursuit of the goal.

In most cases pollution is caused by the externalization of costs. Industrial production, for example, leads to costs for materials, labour, rent, interest and, sometimes, it leads to costs which are not borne by the producing unit but by society at large. These are the costs associated with dumping waste in water, smoke in the atmosphere, and noise onto the surrounding community. The price of the product reflects only part of the costs of production. The private costs are absorbed by the producer while the social costs are absorbed by society. It is these latter costs which cause the deterioration of the environment.

Two general discussion questions emerge: When a common resource has multiple uses, how do we allocate the resource among the competing uses? If problems of pollution, environment and ecological balance are caused by the externalization of costs from a growing industrial society, what options are open to society?

Pollution, Property and Prices treats the first question. Dales points out that at least three methods can be employed to assure a sufficient supply of clean fresh water for competing uses.

1. Establish rules on what can and what cannot be put into the water.
2. Build water treatment plants.
3. Charge for dumping of wastes into the water.

Dales opts for number 3. To operationalize this course of action Dales would establish pollution rights (PR). PRs are rights to dump wastes in the water. By allocating the PRs in a given province, certain regions would be used for industrial purposes while other regions — where fewer PRs were assigned — could be used for recreational purposes. Of course the number of PRs would be a function of type of waste and configuration of the water course.

Since the number of PRs are fixed and since the right of a PR is the right to externalize costs through the dumping of wastes the value of a PR will rise over time.

Over time as the value of a PR rises.

*The ideas expressed in this review are those of the author only and do not necessarily reflect the views of either the Science Council, its Executive Director or others of the Professional Staff.

1. Holders will be tempted to sell to realize financial gains.
2. New entrants into the industry or growing municipalities in a given area will be forced to bid for PRs.

Present holders, which include industry and municipalities, who want to sell PRs will have to either go out of business or build waste treatment plants. New entrants will have to decide whether it pays to buy a PR or build a waste treatment plant. The central point of Dales book is that use of his method will lead to the internalization of costs by polluters and in the course of seeking to avoid these costs the overall amount of pollution will decrease.

The problems in this approach are apparent. We must be able to define how much waste will cause how much harm to a wide variety of waters. We also must know the synergistic effects of different kinds of waste. Finally it is unclear whether a PR is equal to the same absolute amount of different types of waste, e.g., chemicals vs. sewage.

In **The Costs of Economic Growth** the broader issue is raised: the problem of pollution is closely allied to the question of economic growth. In the act of producing the goods and services which make up gross national product, (GNP) a great many costs are passed on to society. Professor Mishan sees many of these costs in their broadest form. The costs of growth are noise, air and water pollution, traffic congestion, traffic injuries and deaths, social tensions arising from the breakdown of established neighbourhoods to provide added expressways for automobile traffic, etc.

The emphasis on growth of GNP as an end in itself has led to a widespread passing on of costs to the public at large. It is these costs which are affecting the quality of life. This is why we see dirty and decaying cities, congestion and noise, unclean air and water in the midst of a high and rising GNP.

Mishan's central message is that GNP as a measure of human welfare is not merely inadequate; it is misleading. The GNP measures only one part of the picture: the goods and services produced and sold. The other part of the story has to do with the social costs incurred in the production of society's goods and services. In any given period we therefore do not know if we are better or worse off than the preceding period: the total costs involved in moving to new GNP levels have never been added up or examined. As a corollary it is clear that the international GNP comparisons are also subject to question. One country may have a higher per capita GNP than others: But what about per capita cost? International GNP competition therefore becomes a simple-minded exercise since the indicator to be maximized does not correctly reflect social welfare.

Thus Professor Mishan would say that to exhort society to produce and consume more so that GNP can grow by a desired yearly percentage is incorrect. The GNP is at best an imperfect and at worst an incorrect guide to social welfare. It is therefore an unsatisfactory index and should not be employed by policy makers who seek to increase social welfare.

Professor Mishan calls into question one of the fundamental assumptions underlying modern industrial society: economic growth is good and rapid economic growth is better. Mishan goes further than merely pointing out the costs of economic growth. He seems to conclude that, on balance, in recent years the costs of growth have out-weighed the benefits of growth, that is, the total benefits which flow from that production.

To this reviewer, Mishan's book suffers from an excess of the description of symptoms and a lack of prescription for a cure. Having said this however, it should, in all fairness, be recognized that one must correctly diagnose the ailment before writing the prescription. The ailment is a method of production which imposes costs on the society at large and therefore the outcome is over-production of goods. There is over-production for the following reason. In economics it is assumed that the market price reflects production costs plus profit. Suppose the government should demand that market prices reflect many of the social costs as well. The effect would be for prices to rise. When prices rise, people tend to buy less. Thus one effect of price not reflecting social cost is that prices are lower than they would otherwise be and therefore there is over production[1].

There is growing evidence of a movement to question growth for growth's sake. The critics seem overwhelmed with the costs of growth: to

[1]One may wish to consider the meaningfulness of the inflationary impact when social costs are passed back to the manufacturer. When prices of goods are made to reflect all costs arising from their production (smoke damage, noise pollution, water pollution) they will rise. Will this kind of inflationary rise be attacked or will it be heralded as an indication that social accounting has taken precedence over private accounting?

stop the costs one must stop the growth. To some this may seem to be the classic case of throwing out the baby with the bathwater. However, there are an increasing number of vocal people who subscribe to the no-growth position. In fact, at the University of California at Santa Barbara a group has emerged which calls itself "the zero GNP growth society". The ecologists and environmentalists tend to be the most militant on this issue. One ecologist contends that "growth for growth's sake is the ideology of the cancer cell". One can easily understand the logic of those who take the no-growth position and it is probably not surprising that the reaction has been so harsh; after all for many years ecnomic growth has been treated as an end in itself. Somewhere along the way economists forgot that increased GNP is a *means*. The ends, presumably are very complex and are intimately related to social goals; however it is not incorrect to note that one widely desired end is a higher quality of life. And to the extent that unplanned GNP growth is having a negative effect on the quality of life, it is clear that the growth dissenters have a valid point. It is also clear that "quality of life" must be defined in a rigorous fashion. It is likely that quality of life can be described by a set of social indicators which in turn can be maximized.

What is our next step? Mishan seems to despair of solving the problem. The ethic of growth is so much a part of our society that it seems improbable that it can ever be halted by a frontal attack. Almost every business or business-related institution has planned for growth and is specifically geared to achieving target growth rates. For all these expectations to be fulfilled, the total GNP must be growing as well.

In this context Mishan's recommendations are sound. The best we can offer our populace are options. Places where they can go so as not to be violated by the external costs of a "prosperous" society. Quiet areas free of jet airplanes. Rivers designated to be kept in a non-polluted state. Quiet areas on beaches and parks where the ubiquitous transistor is banned. People should be allowed to have separate facilities. Those who wish auto-free areas, cities or even regions should be given this choice. Those who want to live in automobile areas, noise zones, etc., would also have the freedom to choose.

It is likely that the simple-minded notion of maximizing GNP growth as an end in itself is no longer tenable. One hopes, however, that society's productive machine is not merely stopped. In this reviewer's view a more desirable outcome would be to concentrate in the production of goods and services which are widely agreed to raise the quality of life. To make this goal more operational it is important that work proceed on a set of widely accepted social indicators. The social indicators can be constructed over a broad range and can even include technologically oriented indicators. For example, it is possible that air and water purity standards or noise level standards can be established. The attainment of these standards can be one of the goals or social indicators. Others would include decreased infant mortality, hospital beds per capita, leisure, city parks per capita, declining communting time to and from place of employment, etc.

The key point is that by concentrating on the fulfillment of social indicators, the configuration of GNP will change as a natural outcome. The relatively faster growing component of GNP will include anti-pollution devices, environmental protection aids, more emphasis on esthetics. Since GNP growth as an end in itself will have been stopped, it will be irrelevant whether GNP grows, stays constant, or drops. The relevant indicators to be increased will then become the social indicators.

ARTHUR J. CORDELL

Economic Advisor
Science Council of Canada
Ottawa
April 15, 1970

Olfaction in Fishes

By Herman Kleerekoper. Indiana University Press, Bloomington and London. 222 pp., 24 pl., 86 text-figures.

Man, being primarily a visual animal, has tended to ignore and neglect study of the sense of smell. But, in spite of this, the study is a fascinating one. Kleerekoper's book reveals many of the latest findings concerning this apparently simple yet highly sensitive organ.

The book is divided into two large chapters, the first one on morphology and function of the organ, and the second on olfaction and behavior. Development, histology, anatomy, physiology, sensitiv-

ity, and theories on function are treated in the first chapter. Although organs of representative taxa are described, the comparative approach is little used, the phylogenetic approach not at all (in fact the dipnoans are out of phylogenetic sequence, placed before cyclostomes and selachians). The data on fishes, which are sometimes scanty, are placed against a background of observations from other vertebrates. This helps give a fuller picture and points out areas needing study.

One learns that the odorant, in water, moves passively into the olfactory chamber impelled by swimming movements, or actively through a pumping process activated by respiration or by ciliary action (p. 59-71). But elsewhere (p. 32) it is reported that ciliary movements were uncoordinated and did not result in unidirectional flow of fluid. Once in the olfactory sac the odorant comes in contact with the olfactory membrane whose convolutions usually form an olfactory rosette. Two cell types, recepter and supporting, are found in this epithelium. The receptors are simply nerve cells whose dendrites point outwards, whose axons join the brain directly, and hence are the most primitive of sensory receptors. The cilia of the receptor cells, which make whip-like movements, may be the site of contact with the odorant. The supporting cells phagocytize disintegrated receptor cells and may secrete mucus. Sensitivity varies but the threshold may be as low as one molecule in the nasal chamber. *Phoxinus* can be trained to distinguish between the odours of 14 species of fish. The olfactory organ clearly has an enormous potential in fishes.

The second chapter deals with olfaction as related to feeding, social behavior, defense (= avoidance of predators), parental behavior, homing, and orientation. Some interesting facets of predator-prey interactions are revealed. Prey may be warned of the presence of predators by detecting odorants emitted by the predator itself (*Gambusia* detects 'esocin' released by *Esox*) or by detecting a fright substance released from the skin of the prey species (of orders Cypriniformes and Gonorhynchiformes) when injured by predators. Predators, as shown by Kleerekoper's own work, may detect prey by their release of "Amine F." An appendix describes Kleerekoper's apparatus and methods for observing and recording locomotor patterns in fishes.

This book is a scholarly work written with considerable care. Numerous references are cited and over 600 appear in the bibliography. Rarely are important references omitted, but Millot and Anthony's (1965) work on the coelacanth, *Anatomie de Latimeria chalumnae*, Tome II, and N. B. Marshall's (1967) study *The olfactory organ of bathypelagic fishes*, Symposium Zoological Society of London 19: 57-70, might be noted. W. Pfeiffer's (1969) important paper in Zeitschrift für Vergleichende Physiologie 56(4): 380-396, on the fright reaction in Gonorhynchiformes apparently appeared too late for inclusion. The illustrations, which include figures of wax models, electroencephalograms, and electron micrographs, are numerous and excellent. Although phylogeny and evolutionary adaptation are given little consideration, anatomy, physiology, and behavior are treated in considerable detail. The book is user oriented with matte paper, a bibiography, and indices to authors, species and subjects.

Olfaction in fishes is a valuable contribution to ichthyology and a reference that most ichthyologists should have on their shelves. It is regrettable that the author, formerly of McMaster University, Ontario is now at Texas A & M University, an example of that less talked about aspect of the brain drain, that of quality.

D. E. MCALLISTER

Curator of Fishes
National Museum of Natural Sciences.

Germination and Establishment of Weeds for Experimental Purposes

By Robert N. Anderson. The Weed Science Society of America, 2025 Burlison Drive, Urbana, Illinois, 61801, 1968, x + 236 pp., $5.00 (US).

On first glance, you may be greatly amused by the title of this book. However, weed scientists will tell you ruefully that many weeds (and other kinds of plants) cannot be grown where and when they are wanted. In an attempt to remedy this situation, the author has summarized information on the propagation of more than 900 species which are arranged alphabetically according to their Latin names. Most of this information deals with seed germination, but comments on vegetative reproduction are presented where applicable.

Anderson has assumed a very wide interpretation of the word "weed, consequently his book will prove valuable to many people who are not weed scientists. In addition to plants that grow in arable land, he presents information on woodland herbs,

marsh and meadow species, aquatics, drug and latex plants. Woody species are only included if they are known to be weedy.

Instructions for propagating individual species comprise most of the book, but there is also a brief but extremely valuable section where general principles for propagation by seed or vegetative means are described. If the author does not deal thoroughly with a particular technique, he provides a useful reference.

Although Anderson claims that his compendium is not confined to weeds of a single part of the world, the majority of his 643 references are North American in origin. A good selection of Canadian material is included. In contrast, references in other languages are given somewhat cavalier treatment. (e.g. for *Hyoscyamus muticus* the notation is simply "Binet (54) reported in French on seed dormancy").

Readers who are unfamiliar with Latin names of plants will probably have to use a local flora in conjunction with this book. There is no index of common names; however the accepted American common names (where applicable) are given after the Latin name.

With the current trend to greater use of experiments in natural science classes, this book will be extremely valuable to teachers who want to grow wild plants in their classroom or out of doors.

PAUL B. CAVERS

Department of Botany,
University of Western Ontario,
London 72, Ontario

L'évolution régressive des Poissons cavernicoles et abyssaux

Par G. Thinès. Masson & Cie, Paris, 1969. 394 pp., 123 figs., 29 tableaux. 95 F.

Malgré le nombre relativement infime des espèces de poissons régressés ou aveugles (moins que 1% du total de la faune ichtyologique), on ne peut s'empêcher de souligner leur importance dans notre compréhension des phénomènes évolutifs. Cette constatation se vérifie dans l'ouvrage de synthèse que le Professeur George Thinès, de l'Université de Louvain, leur a consacré, le plus complet paru à ce jour.

Dans l'introduction l'auteur pose les problèmes auxquels il confrontera le lecteur. Il résume le cheminement des théories scientifiques émises au sujet de la régression chez les poissons, et leurs portées anatomophysiologique, écologique et éthologique. Le premier chapitre est un véritable catalogue descriptif englobant la plupart des espèces reconnues "aveugles". Ceci inclut quelques Agnathes et Téléostéens du littoral qui ne fréquentent pas strictement les nappes d'eau souterraines ou les abysses océaniques. Plusieurs données histologiques (oeil, cerveau, hypophyse, thyroïde) et descriptions méticuleuses d'habitats hypogés (grottes, puits) accompagnent la systématique des espèces.

Le second chapitre s'attarde à décrire et discuter les principales régressions des Poissons cavernicoles et abyssaux: les régressions oculaires, pigmentaires et cérébrales. L'auteur nous fait suivre les étapes ontogéniques de la régression oculaire chez quelques cavernicoles (*Caecobarbus, Anoptichthys, Amblyopsis, Lucifuga, Stygicola*). Le troisième chapitre est consacré à une analyse profonde de la zoogéographie et de l'écologie des poissons aveugles. Le quatrième chapitre donne le ton à tout l'ouvrage, puisqu'il discute longuement les aspects paléoécologiques et évolutifs des régression chez les poissons. A cet égard, Thinès passe en revue les nombreuses théories ayant cours depuis Darwin jusqu'à Vandel sur l'origine des faunes régressées. L'esprit critique de l'auteur se fait sentir de manière féconde à travers tout ce chapitre. Selon Thinès, il faut douter qu'un poisson aveugle, dans sa niche hypogée, ait un potentiel de survie moindre que celui de la forme parente, épigée. Le chapitre cinquième, consacré aux divers comportements des poissons cavernicoles, a le désavantage de mal s'intégrer dans l'important chapitre précédent. L'originalité de Thinès s'est toutefois manifestée dans sa conception fondamentale des régressions psychophysiologiques et éthologiques.

En rétrospective, l'ouvrage de Thinès est de présentation agréable et la qualité typographique est excellente. On doit cependant déplorer que la plupart des illustrations ne soient pas référées dans le texte, et que certaines références du texte ne soient pas retrouvées dans la liste bibliographique à la fin du volume. Cette dernière, par ailleurs, ne peut prétendre être complète, quoiqu'exhaustive. Un index assez complet des auteurs et des matières et une table des matières sont à la disposition du lecteur averti.

Tenant compte de l'état actuel de nos connaissances sur les poissons aveugles, on se doit d'admettre que l'oeuvre de Thinès, synthèse excep-

tionnelle, sera précieuse tant pour le profane éclairé que pour le spécialiste. Un des mérites de l'auteur est d'avoir évoqué de façon implicite, et ce à chaque chapitre traité, les nombreuses perspectives d'avenir qu'offre ce sujet.

MICHEL ANCTIL

Département de Biologie,
Université d'Ottawa,
Ottawa 2, Canada.

Vascular Plants of the Pacific Northwest, Part I: Vascular Cryptogams, Gymnosperms and Monocotyledons

By C. Leo Hitchcock, Arthur Cronquist and Marion Ownbey. Seattle, University of Washington Press 1969. 914 pp., illus. $25.00 (US).

This is the final volume of a set of five which began with Part V: Compositae (1955) and was continued in Part IV: Ericaceae through Campanulaceae (1959), Part III: Saxifragaceae to Ericaceae (1961) and Part II: Salicaceae to Saxifragaceae (1964). Part IV was reviewed in this Journal (Can. Field Nat. 74: 56. 1960) and Parts III and II again in this Journal (Can. Field Nat. 79: 204-205. 1965) by James A. Calder.

This volume, like the others, includes detailed descriptions of all taxa recognized for the area encompassed by Washington, northern Oregon, Idaho north of the Snake River, the mountainous region of western Montana and southern British Columbia, together with keys for genera, species and varieties. Genera and species are in alphabetical sequence within each family. Full literature references are given for all names, including synonyms, and types are cited. Habitat, total distribution and flowering time are also included. Of particular value are the discussions which follow the descriptive data for nearly every species. Chromosome numbers are included where known, but no vouchers are cited, nor is there any indication as to whether the counts are based on plants from the Pacific Northwest.

The genera *Allium* and *Calochortus* in the Liliaceae were written by Ownbey, the vascular cryptogams and the Cyperaceae by Cronquist, and the remainder by Hitchcock. As in the other volumes, the treatment is conservative. There are at least 50 transfers throughout the book and four new varieties are described. Normally I would object to the inclusion of such transfers and descriptions of new taxa in a modern flora, rather than publishing them separately in a taxonomic journal where they might be readily found by the Gray Card Index bibliographers, but I believe that this volume and the others that go with it, with all the bibliographic data which they contain, form a legitimate exception.

A unique feature is the inclusion of a key to the species of grasses based on vegetative characters as well as one to grass genera based primarily upon floral characters. These characters are amply illustrated.

Line drawings by Jeanne R. Janish appear on almost every page in the book. There are full drawings of most species and for many there are enlarged drawings of floral parts, seeds and other diagnostic features. All compare very favorably with her drawings and those by John H. Rumely in the earlier published volumes.

This volume contains several sections which relate to the work as a whole: an Index to the Divisions of Vascular Plants (there are both synoptical and artificial keys to the monocotyledonous families; the key to dicotyledons is found in Part II), a Glossary, an Index to all five volumes, and Addenda to Parts II-V which include two transfers which might easily be overlooked.

The angiosperm families in Parts II to V were in the familiar Englerian system. The monocots published in the present volume however follow the more natural sequence recently published by Cronquist (The Evolution and Classification of Angiosperms, Houghton Mifflin, 1968). The taxonomy and nomenclature of the divisions and classes of vascular plants follows the paper by Cronquist, Takhtajan and Zimmermann in Taxon 15: 129-134. 1966.

This volume like the others is an absolutely essential tool for students of the flora of the northwestern United States and adjacent territories, and indeed much of North America. I can only echo the reviewer of the earlier volumes in stating "I strongly recommend this flora to both the amateur and professional and would like to stress that it is indispensable to those interested in the flora of the Pacific Northwest."

W. J. CODY

Plant Research Institute
Central Experimental Farm
Ottawa 3, Ontario, Canada.

The Geography of Life

By Wilfred T. Neill. Columbia University Press, New York and London. 480 pp. 1969. $12.95 (US).

The purpose of this book is "chiefly to portray the broad outlines of animal and plant distribution in all parts of the world, to review the geography of life on land, in fresh water and in the ocean". Since the scope of biogeography is vast and no one book can contain all of the aspects related to the subject, the level at which the author has aimed his book is important. For most professional biogeographers the book would seem to be written at a rather introductory level. People that have a general familiarity with plants and animals and know at least the generic names of commoner plants and animals will find the book extremely interesting. The author writes well and there are numerous illustrations of excellent quality. For one interested in numerous factual remarks concerning odd distributions, the origin of many of our economic plants, the problems of introductions, and many other miscellaneous items relating to the distribution of animals and plants, the book will be a mine of information. However, as with any book of this type, the question of which type of information to include and which to omit is obviously a problem. There are chapters dealing with animal distribution, and others considering plant distributions. However, in some of the chapters on plant distributions the author digresses and includes animals associated with the particular area. This at times lends a somewhat confused aspect to the subject matter as presented. This is not a serious fault as one's primary purpose for reading the book would be to obtain the overall picture of plant and animal distributions. In addition to discussions of terrestrial distributions are chapters concerning continental drift and animals with marine distributions. I found most of the information contained in the book reasonably accurate and it is recommended for anyone interested in general natural history.

My recommendation for the book does not extend to the more advanced level of the serious student of biogeography because of one serious fault. There are numerous statements that are of interest but there are no references to the authors of the statements. This means that there is no way of checking on factual information. At the end of the book there is an extensive bibliography which is not referred to in the text. The bibliography contains a large assortment of papers, some old, some fairly recent, some good, others questionable. If the reader had been given an indication of the coverage of each paper or the usefulness of a particular work, it would have been of considerable assistance. The illustrations, which are of excellent quality and of general interest, are unfortunately not referred to in the text, and are salted around, seemingly regardless of the pertinence to the text.

In summary, 'The Geography of Life' can be recommended for the general reader who wants to have some idea of plant and animal distributions in the world, but for the more serious student the book has various shortcomings including rather vague answers to questions posed on the fly leaf. To be fair, I cannot say that I have seen any other book dealing with the general topic that does a noticeably better job with the subject material. My main objection is that the references to various statements are omitted and this I consider a truly serious fault.

H. F. HOWDEN

Department of Biology,
Carleton University,
Ottawa 1, Ontario.

Seashells of North America: A Guide to Field Identification

By R. Tucker Abbott. Golden Press, New York. 280 pp., 112 col. plates, 2 maps, numerous text figs., 4½ × 7½ inches, 1969 (dated 1968). Plastic-coated paperback. $3.95; clothbound $6.95 (US).

This is the third of the excellent Golden Field Guides. Like all of Dr. Abbott's books it is extremely well-written, informative, and comprehensive. The illustrations by George F. Sandstrom are in natural colour and are so realistic that identification of most of the species should be quick and uncomplicated.

The introductory section is unusually inclusive. Twenty-seven general subjects are discussed. Some of these are: What is a Mollusk?, Evolutionary History, Reproduction, Development, Growth, Sexuality, Feeding, Locomotion, Nervous System and Sense Organs, Marine Communities, Marine Faunal Provinces, Guide to Collecting Areas, Collecting Mollusks, and The Shell Collection. The following 220 pages contain coloured figures and

brief diagnoses of the 850 most abundant and colourful species (in phylogenetic order) together with remarks on the distribution, ecology, and relative abundance of each. A selected bibliography and an index complete the work.

This book was apparently written for use by persons who are not experienced collectors. Introductory works are frequently filled with generalizations which are more provocative than precise and this work is no exception. For example, nearly all quantities, lengths, and depth ranges are expressed in only one significant figure, e.g. 20 to 30 eggs, 6 to 8 inches, 5 to 500 fathoms, etc. Such approximations should not be taken too seriously. In the introductory section and elsewhere the general topics discussed are very seldom related to particular species. The knowledgable reader who desires specific information might well be disappointed.

There are some misstatements regarding the Canadian fauna which must be mentioned. Page 35 contains a map of molluscan faunal provinces which shows the outer coast of Labrador, James Bay, and most of Hudson Bay as within the Boreal Region. Those areas should be shown as Arctic. The "Magdalen Pocket", region of warm summer water in the Northumberland Strait and vicinity is depicted as being much more extensive than it really is. The name Northumberland Pocket would be more appropriate. The Magdalen Islands are located outside and well to the north of this warm-water region.

Pages 42 and 43 contain a discussion of cleaning and preserving specimens and include mention of some techniques for removing the soft parts which, in my opinion, are unnecessarily brutal and should have been omitted. On the other hand a statement urging the preservation of the soft parts of rare and little-known species might well have been included. More emphasis might also have been given to the desirability of recording precise locality and habitat data in a collection catalogue. This is especially necessary if the collector wishes his collection to be of real value to scientists or eventually to be accepted by a modern museum.

Although the book contains some inaccuracies and typographical errors it would be a mistake to conclude that it is not desirable or useful. On the contrary, there is incomparably more about it to compliment than to criticize. It is an excellent value for the price and will be a source of instruction and great pleasure to all of those who are interested in life in the oceans or in the fascinating world of sea shells. The book is heartily recommended.

A. H. CLARKE

National Museum of Natural Sciences,
Ottawa 4, Ontario.

Handbook of North American Nut Trees.

Edited by R. A. Jaynes. Published by Northern Nut Growers Association, 4518 Holston Hills Road, Knoxville, Tenn. 37914, vii + 421 pp., Illus. 1969. $7.50 (US).

"Nuts" — to most Canadians this word refers to exotic fruits such as peanuts (not a nut), pecans, brazil nuts, pistachios, etc. Those who have lived in rural Southern Ontario are perhaps more lucky than those in the rest of Canada. They have hickories, walnuts, in years past the sweet chestnut, and as well butternuts and hazelnuts which are native over a somewhat wider range of Canada.

Our neighbours to the south are more fortunate in that nut trees are native over a greater part of their country. However, today even in southern Ontario and most parts of the U.S.A. the wild nut tree is becoming a memory of the past. If future generations are to enjoy our native and exotic nuts, more will have to be cultivated as orchard, shade or even street trees.

This book has brought together under one cover the broad knowledge of North America's foremost "nut" experts. Chapters cover all such necessary topics as culture, propagation, disease and insect problems, species and selections available. The work of Canadians, the late Rev. Paul Grath of Toronto with introductions of the Carpathian walnut, just now becoming available from Canadian nurseries, and J. V. Gellatly of Westbank, B.C. with filberts and other nuts receives due mention and credit. It is unfortunate that nut trees are not more widely available from Canadian nurseries, but difficulties with propagation, transplanting and culture have kept nut tree growing from becoming more popular. This book with its wealth of information will, I hope, go a long way to provide Canadians as well as Americans with the needed information. The Northern Nut Growers Association is to be congratulated for publishing this much needed reference work.

L. C. SHERK

Chief Horticulturalist,
Sheridan Nurseries Ltd.,
Etobicoke, Ontario.

OTHER NEW TITLES

Atmospheric Emissions. B. M. McCormac and A. Omholt (Eds.). Proceedings of the NATO Advanced Study Institute held in Norway. Discussions and lectures on sky observations, particles and effects, chemical fallout, fundamental causes with interpretations. Van Nostrand, 1969. 563 p. $27.00.

The Biological Aspects of Water Pollution. C. G. Wilber. Explains what happens to the biology of waters that become progressively more and more polluted. Excellent references. C. C. Thomas and Co. Springfield, Ill., 1969. 296 p. Illus. Ca. $24.50.

Nature Sleuths. J. J. McCoy. Written for boys and girls; considers causes and trends toward extinction of many species of wildlife; considers conservation laws and management problems. Lothrop and Co. 1969. Ca. $5.50.

Venomous Reptiles. S. A. Minton, Jr., and M. R. Minton, Charles Scribner's Sons, New York, 1969. Illus. 274 p. Ca. $8.50.

Wildlife Management Techniques. R. H. Giles, Jr., 3rd revised edition. The Wildlife Society, Washington, D. C. 1969. 623 p. Illus. $10.95.

Ecological Aspects of the Mineral Nutrition of Plants. I. H. Rorison (Ed.). A symposium of the British Ecological Society, Sheffield, April 1-5, 1968. F. A. Davis Co., Philadelphia, Pa., 1969. Illus. Ca. $18.00.

Handbook of Rocky Mountain Plants. Ruth A. Nelson, Contains descriptions of some 975 different plants in 88 families. Dale Stuart King, 1969. For the amateur botanist 12 color plates, 331 p. Ca. $7.50; paperback $5.50.

A Digest of Environmental Pollution Legislation in Canada. The Canadian Council of Resource Ministers, 1970. An 800 page publication in two volumes on water, air and soil pollution control and solid waste disposal. The legislation and regulations contained therein have been compiled for Canadian Industries Limited by N. E. Cooke, R. M. Cooper and Jacques Pilon of C.I.L. This unique report provides a timely and valuable reference for the increasing number of Canadians concerned with the judicious management of our deteriorating environmental resources. As changes will continue to be made at a rapid rate for at least the next 10 years, C.I.L. will continue to gather new legislation, and publish occasional supplements and up-dated editions. Available from the Secretariat, Canadian Council of Resource Ministers, 620 Dorchester Blve., W., Room 830, Montreal 101, P.Q. $10.00.

Ecotactics: The Sierra Club Handbook for Environment Activists. Introduction by Ralph Nadar. Published jointly by the Sierra Club and Pocket Books. This book is the first publication in a program keyed to guide the efforts of members and friends of the Sierra Club in the fight to save the environment. Paperback, Ca. $1.00. Available from Sierra Club, 1050 Mills Tower, San Francisco, 94104. U.S.A.

Pictographs in the Interior of British Columbia. John Corner. Available from the author at R.R. 4, Vernon, B.C. 1968. 125 pages, believed about $1.50 and $4.50 for paperback and hard covers respectively. Printed by Wayside Press. This is a manual about the paintings of native peoples.

Exploring Manning Park. Robert Cyca and Andrew Harcombe, with photos by Gundy and Bernie Epting. Gundy's and Bernie's Guide Books, 2315 Alma Rd., Vancouver 8, B.C. 96 p. $2.95.

The Ultimate Folly. Richard D. McCarthy. "War by pestilence, asphyxiation and defoliation" by a U.S. congressman "who has uncovered the Pentagon's huge secret reserves of chemical and biological weapons and has launched the national drive to control them." Alfred A. Knopf, Inc., 1969. 176 p. $5.95 (US).

The Interaction of Science and Technology. W. Dale Comptor. University of Illinois Press, Illinois. 137 p. $5.50.

Chemicals from the Atmosphere. C. H. Simpson. Doubleday and Co., Inc., New York, 1969, $5.50; paperback $1.60.

Eutrophication: Causes, Consequences, Correctives. Proceedings of a Symposium. National Academy of Sciences, Washington, D.C., 1969. Illus. 661 p. Ca. $14.50.

The Wildlife Wetlands and the Shellfish Areas of the Atlantic Coastal Zone. G. P. Spinner, The American Geographical Society, New York, 1969. 4 p. Illus. (12 plates) $12.00 (US).

Antarctic Ecology. M. W. Holdgate (Ed.), Volume 1. Academic Press, London and New York, 1970. Illus. 604 p. Ca. $19.00.

Endangered Wildlife of Canada. Canadian Wildlife Federation, 1419 Carling Ave., Ottawa 3. Illus. 15 p.

Butterflies of the Niagara Peninsula. E. G. Bailey. Special Publication No. 1 of the Niagara Falls Nature Club, April, 1970. 19 p. Mimeo.

Plants of the Niagara Peninsula. Gustave J. Yaki. Special publication No. 2 of the Niagara Falls Nature Club. April, 1970. 44 p. Mimeo.

Bird Life of Canada's Niagara Peninsula. R. W. Sheppard. Special Publication No. 3 of the Niagara Falls Nature Club, April, 1970. 85 p. Mimeo.

Ecological Effects of the War in Vietnam. Science, Volume 168, pages 544-554. Tables and Illustrations.

The Biology of Mosquito-Borne Disease. P. F. Mattingly. Allen and Unwin, London, and Elsevier, New York, 1969. 184 p. Illus. Science of Biology Series, No. 1. $7.00.

Towards a Better use of the Ocean. Contemporary Legal Problems in Ocean Development. W. T. Burke. Comments and recommendations by an international symposium, Stockholm, June, 1968. Humanities Press, New York, 1969. SIPRI Monograph. $7.50 (US).

A Geography of Population: World Patterns. G. T. Trewartha. Wiley, 1969. This, first of three volumes considers the worldwide distribution of populations, past and present, and also the biological and cultural aspects. Illus. 186 p. $6.95 (US).

Conservation: Now or Never. Nicholas Roosevelt. Dodd, 298 p. $5.95 (US).

Fish Red Data Book. Volume 4 of the International Union for the Conservation of Nature and Natural Resources Red Data Book Series for freshwater fishes, is now available from IUCN, 1110 Morges, Vaud, Switzerland for 25 Swiss francs. The compiler of the book is Dr. R. R. Miller (U.S.A.) and 78 endangered fishes are included.

Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Published by the International Lake Erie Water Pollution Board, and the International Lake Ontario - St. Lawrence Water Pollution Board. 1969. 151 p. Illus. Report to the International Joint Commission.

Transactions of the Thirty-third Federal-Provincial Wildlife Conference held at Edmonton, Alberta, July 8-10, 1969. Canadian Wildlife Service, Ottawa. Queen's Printer. 101 p.

Environment 1975: Pollution in Alberta. D. A. Brookes and M. T. Myres, (Eds.). A Symposium sponsored by the Biological Sciences Society, University of Calgary. Obtainable by sending $1.50 to Dr. M. T. Myres, Dept. of Biology, Univ. of Calgary. This 62 page $8\frac{1}{2} \times 11$ offset publication includes five papers on many aspects of the pollution problem in Alberta. The papers are followed by a Panel Discussion and then by audience participation. The symposium is a valuable contribution to public-oriented literature that serves to make the average citizen more aware of the kind of world that his children are inheriting. The proceedings end with 6 pages of useful general references.

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist will be open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

(See Instructions to Contributors inside back cover)

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

Normally, only solicited reviews are published. The editor invites biologists and naturalists to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "Other New Titles".

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

Instructions to Contributors

Manuscripts

Authors should submit two manuscripts (original and carbon copy), each complete with abstract, tables, and illustrations. Manuscripts should be typewritten on paper measuring 8½ x 11 inches. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Words meant to appear in italics should be underlined. Every sheet on the manuscript should be numbered.

Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text in all manuscripts except in letters to the editor. In no case should any words be abbreviated; this includes references to tables and figures as well as literature citations.

The tables should be titled and numbered consecutively in arabic numerals. Tables should be placed each on a separate page after the Literature Cited. Captions to figures should be typed together on one page. Authors are requested to use at least one given name.

The **Style Manual for Biological Journals** is recommended, in general, as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be as determined by the editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Coordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted without space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly 7½ × 5¾ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors are asked to share the cost of publication by paying $22.00 for each page in excess of six journal pages. The cost of illustrations and the setting of tables and of small-sized type are also normally charged to the author.

Reprints

Reprints, with or without covers may be purchased. The cost is given on the reprints order form which is attached to the galley proofs. Members in good standing can request a 10% reduction in reprint costs.

Affiliated Societies

Edmonton Bird Club

President, P. H. Thompson; *Honorary President,* R. Lister; *Past President,* J. C. Finlay; *Vice-President,* K. W. Smillie; *Treasurer,* R. Heath; *Field-Secretary,* R. W. Turner; *Audubon Representative,* P. DeMulder; *Secretary,* Miss M. J. Wade, 6519 94 St., Edmonton, Alberta; *Librarian,* Mr. A. W. Rupp, 97 Westbrook Dr., Edmonton 76, Alberta.

Calgary Field-Naturalists' Society

Address: Box 981, Calgary 2, Alberta, *President,* Dr. John Powell; *Vice-President,* Peter Karston; *Secretary,* W. Garry McKay; *Treasurer,* Margaret Powell; *Directors,* Mrs. Hattie Boothman and Dr. M. T. Myres; *Editor,* The Calgary Field-Naturalist, John W. Price.

McIlwraith Field Naturalists' Club

President, Mr. Ted Maddeford; *Past President,* Dr. W. H. Minshall; *Vice-President,* Mrs. Spencer Inch; *Corresponding Secretary,* Miss Margaret Ross, Apt. 9, 179 Oxford Street East, London; *Treasurer,* Mrs. Walter Wake, 1354 Longmuir Ave.; *Chairman Audubon Films,* Mr. G. Fred Bates, 366 Burlington Crescent, London; *Chairman Conservation Council,* Mrs. P. W. Tracey, 261 Briscoe St., London; *Editor,* Cardinal—Dr. Frank Cook, 1 Larkspur Crescent, London, Ont.

Vancouver Natural History Society

President, Mrs. W. J. Smith; *First Vice-President,* Mr. A. W. Greenius; *Second Vice-President,* Mrs. J. M. Anderson; *Treasurer,* Mr. E. G. Barnes, Box 3021, Vancouver 3, B.C.; *Corresponding Secretary,* Mrs. H. Pinder-Moss; *Membership chairman,* Mrs. E. Barnes; *Editor,* VNHS Bulletin, Mrs. R. A. Pilkington.

Nova Scotia Bird Society

President, Dr. Eric Mills; *Vice-President,* Dr. B. K. Doane; *Past President,* Dr. Ian A. McLaren; *Editor,* Mrs. J. W. Dobson; *Membership Secretary,* Miss E. Crathorne; *Secretary-Treasurer,* Miss M. Claydon, c/o Nova Scotia Museum of Science, Summer Street, Halifax, Nova Scotia.

Province of Quebec Society for the Protection of Birds

President, Mr. M. D. Spencer; *Vice-Presidents,* Mrs. E. S. Cooper, M. H. Ouellet; *Honorary Treasurer,* Miss G. E. Hibbard; *Honorary Secretary,* Mrs. G. H. Wightman, 40 King's Rd., Pointe Claire, P.Q.; *Librarian,* Mrs. E. Brosseau.

Toronto Field Naturalists' Club

President, Mr. Clive Goodwin, 11 Westbank Crescent, Weston 626, Ontario; *Vice-President,* Miss Rosemary Gaymer; *Secretary,* Mrs. H. Robson, 49 Craighurst Ave., Toronto 12, Ontario; *Treasurer,* Mrs. Dorothy Mathers; Editor, Miss Margaret Jeffry; *Junior Club,* Mr. Robert MacLellan, 416 St. Clements Ave., Toronto 12, Ontario.

The Saskatchewan Natural History Society

Honorary President, Fred G. Bard; *President,* Gordon Silversides; *Past President,* W. A. Brownlee; *First Vice-President,* J. A. Wedgewood; *Treasurer,* George R. Dodd, 33 Malone Crescent, Regina, Sask.; *Corresponding Secretary,* Mrs. Leith Knight, 843 Elgin Avenue, Moose Jaw, Sask.; *Editor,* The Blue Jay, George F. Ledingham, 2335 Athol St., Regina, Sask.; *Assistant Editors,* Margaret Belcher and Robert W. Nero; *Editor* of Newsletter, James Slimmon, 2526 Hanover Ave., Saskatoon, Sask.

THE CANADIAN FIELD - NATURALIST

PUBLISHED BY

The Ottawa Field - Naturalists' Club

BOX 3264, POSTAL STATION 'C'
OTTAWA 3, CANADA

Second Class Mail Registration No. 0527
Return postage guaranteed

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Special Issue

dedicated to the survival of the Peregrine Falcon

Volume 84, No. 3 Ottawa July-September, 1970

The Ottawa Field-Naturalists' Club

FOUNDED IN 1879

Patrons

Their Excellencies the Governor General and Mrs. Roland Michener.

The objectives of the Club are to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to co-operate with organizations engaged in preserving, maintaining or restoring quality environments for living things.

The Club is a corporate member of the Federation of Ontario Naturalists.

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by the Ottawa Field-Naturalists' Club with the assistance of affiliated societies and of a contribution from the Canadian National Sportsmen's Show. All material intended for publication should be addressed to the editor. Opinions and views expressed in this journal are private and do not necessarily reflect those of the Ottawa Field-Naturalists' Club or any other agency.

Membership and Subscription

The annual membership fee of $5.00 for individuals covers subscription to the journal. Libraries and other institutions may subscribe at the rate of $10.00 per year (volume). Applications for membership, subscriptions, changes of address and undeliverable copies should be mailed to: Treasurer, Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa 3, Canada. Return postage guaranteed.
Second class mail registration number 0527.

Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919), are obtainable from the Business Manager.

Cover Photographs: Peregrine Falcon activities on and around the Sun Life Building, Montreal in years prior to the widespread contamination of the environment by persistent chemicals. See reprint of article on the Story of the Sun Life Falcons, page 209 in this issue. Photos by G. Harper Hall.

I would like to become a member of THE OTTAWA FIELD-NATURALISTS' CLUB and to receive the quarterly journal THE CANADIAN FIELD-NATURALIST

Name (Dr., Mr., Mrs., Miss) ....

(In block letters)

Address ....

....

....

....

(Include postal zone)

I would like my membership to start with

January of 1970 ☐

January of 1971 ☐

My membership fee of $5.00 is enclosed.

....

(Signature)

(Mail to) Treasurer,
Ottawa Field-Naturalists' Club,
Box 3264 Postal Station 'C',
Ottawa 3, Canada.

Please note that all library and institutional subscriptions to THE CANADIAN FIELD-NATURALIST are $10.00 a year (volume)

The Canadian Field-Naturalist

VOLUME 84 JULY-SEPTEMBER, 1970 NUMBER 3

TABLE OF CONTENTS

(*continued overleaf*)

Notes

Letters

Reviews

Peregrine Falcons, Pollutants, and Propaganda

During the past eight years, the Peregrine Falcon has received more concentrated attention from the scientific community than it has in the past century. This has generally been a rather difficult species to study in the field. Almost inevitably, and with certain brilliant exceptions, scientists in the past have left the field study of the Peregrine to amateur ornithologists, falconers, and naturalists. The Peregrine, however, has had two important characteristics that made it a focal point of great strategic interest to ecologists in the 1960's. On the one hand, the bird's cosmopolitan distribution was the common denominator that drew attention to similarities in the simultaneous collapse of certain raptor populations on two continents. And on the other hand, the bird's remarkable resistance to human persecution and exploitation and its well known centuries-old use of traditional cliffs made its recent precipitous decline an event of startling magnitude that ornithologists could not ignore.

Research on the Peregrine and other raptors in the past eight years proved to be full of surprises. The dramatic story of the Peregrine's simultaneous decline on two continents was sketched in by almost a score of observers. The extraordinary discovery that many of these birds were eating their own eggs was documented by D. A. Ratcliffe and others and shown by him to result from an unprecedented change in eggshell thickness that evidently led to accidental breakage of the eggs. This change was rapidly found to extend to at least a dozen other species, many (but not all) of which had exhibited major regional population declines. In North America, the change was then demonstrated to be invariably correlated with DDE, the seemingly innocuous breakdown product of DDT and a widespread environmental pollutant known even in the Arctic and the Antarctic. Finally, in a critically important series of experiments, the U.S. Interior Department's Patuxent Wildlife Research Center reproduced the same reproductive failures by placing captive Mallards and Kestrels on a diet of 3 ppm (wet weight) DDE. Today, DDT stands proven in the eyes of many ecologists as a compound of wildlife extinction. It will certainly wipe out one subspecies of the Peregrine, and it has placed another on the endangered list. It will not wipe out the North American Robin, as Rachel Carson predicted, nor the Bald Eagle, as she hypothesized. But it will wipe out some regional populations of this eagle, and its insidious effects on other species of raptors and fish-eating birds are now being steadily documented.

These pesticidal effects have been frequently extrapolated by sensationalists to include human health. And the food-faddists are having a field day. ("Farm fallout can kill you!") The human populations of Canada and the United States, however, generally live on a monitored diet, and their exposure to DDT or DDE is quite different from that of species at the tops of natural ecosystems. In addition, the sublethal effects of DDE on birds still await a precise physiological explanation that remains to be elucidated; and there is little evidence yet that the chlorinated hydrocarbons will have a similar adverse effect on human health.

The reaction of agriculturalists to all these ecological findings has followed the three-step idea-acceptance syndrome set forth some years ago by C. L. Huskins:

(1) "We do not believe it." In this stage, there were skeptical objections (a) that pre-1940 soil samples showed the seeming presence of chlorinated hydrocarbon insecticides on a gas chromatograph (they do, irrelevantly, on a parts per *billion* basis), (b) that the same analytical techniques were confusing PCBs with the presence of DDT (true for p,p′-DDT and p,p′-TDE; not true for DDE) and (c) that other pollutants like cadmium, mercury, and lead had not yet been ruled out (can Science ever really prove a negative?). This stage is almost past.

(2) "It is of no importance anyways." This is now the main argument of the National Agricultural Chemicals Association propaganda campaign. Gamebird-harvest figures are quoted to prove that the environment is really free of pollutants. Songbird-census statistics are enumerated. Maximum migration counts at the Hawk Mountain Sanctuary are quoted without mention of weather variables or long-term trends. The NACA argument is largely what one may call the Argument of the Averted Glance.

(3) "We knew it all the time." This stage is yet to come.

The NACA propaganda drive includes a "Speaker's Kit" with such statements about wildlife as "Body residues cannot build up until they kill an animal," a section on "Wildlife (Prospects)" epitomizing the Averted Glance, and the confident reassurance, "Armed with the Speaker's Kit you are ready to speak for pesticides on any occasion and at a moment's notice." There is some evidence that agriculturists are falling for this line. One University of Nebraska publication recently even rehashed the old Christmas birdcount statistics on

grackles, blackbirds, Cowbirds, Starlings, and Robins — an intellectual trap that back in 1965 E. E. Kenaga showed to be critically biased as a population index (Bull. Entomol. Soc. Amer., 11: 81-83). Even an undergraduate ornithologist would have known enough to avoid that one.

What does give one cause for concern is the temptation facing modern scientists to discuss and analyze pollution phenomena outside their own fields of personal competence. To succumb to this demand (and it is a demand often placed on us by society) can often jeopardize the integrity of the scientific community. We are beginning to suffer from too many instant-ecologists, instant-entomologists, instant-oceanographers, and the like.

Between the different scientific disciplines there exist intellectual gaps that are widening with the mounting deluge of specialized research reports that few of us have time to master. When fields like entomology, ornithology, and ecology come together, as they do briefly in insecticide pollution, we are in need of new techniques to bridge information gaps that are almost inevitable. Perhaps some sort of information exchange could be set up by liaison committees that condense key bibliographies, review crucial research reports, and publish terse summaries of these in the existing newsletter of a sister society with which the committee is not formally associated.

In the meantime, the research challenges in pollution ecology remain just as great. There is no doubt that some bird populations had to decline as reproductive success (brought on by eggshell breakage) became subnormal and remained so. In Pennsylvania, according to J. N. Rice, Peregrine Falcon productivity dropped to about 0.4 young fledged per occupied site (normal, about 1.1) in 1947-60. This decline in potential recruitment should have resulted in a long slow population decline of about 10 percent per year. Instead, the decline in this period was annually greater than 20 percent; some unrecorded increase in adult mortality rates therefore must have also taken place. The decline of the Peregrine in the eastern United States thus was too rapid to have been caused by reproductive failure alone.

In a small study area in western Pennsylvania, E. C. Schriver, Jr., reported 3 out of 4 pairs of Cooper's Hawks failing to return to their nesting territories after the hard winter of 1959-60 (really from mid-February to late April). It is possible that this sudden increase in adult mortality really was similar to the syndrome reported by R. F. Bernard when DDT-laden House Sparrows were subjected in the laboratory to starvation. While experimental data on delayed mortality from DDE are currently lacking, the field evidence points to both reproductive failure and increased adult mortality as taking place in the population crashes of several raptors. This hypothesis, long postulated for the British Peregrine by Ratcliffe, appears to hold for Connecticut Ospreys as well as for eastern U.S. Peregrines. Some evidence of dieldrin poisoning in fully grown Bald Eagles has also been reported by W. L. Reichel et al., but contaminated ecosystems producing such mortality remain to be identified.

With dieldrin, mercury, and PCB's now found in varying degrees in the North American environment, the exact significance of chemical pollutants takes on increasing complexity. It is somewhat reassuring to notice, in a paper given in September 1970 by R. G. Heath et al. at the XVth International Ornithological Congress at The Hague, that dietary (dry-weight) levels of 25 and 50 ppm of Aroclor 1254, a group of PCB's commonly found in many ecosystems, have produced no measurable productive effects in captive Mallards and Bobwhite and that Aroclor toxicity was generally less than that of DDT in four species of birds that they studied under controlled conditions. It does not follow, however, that these toxicological effects are necessarily true of other taxonomic groups, including the raptors.

What has really emerged in these relatively recent studies of the Peregrine Falcon, other raptors, and fish-eating birds is a new integration of field and laboratory research on two continents. Ornithology, chemistry, ecology, meteorology, pharmacology, and toxicology are represented in the scientific disciplines that have been brought together. This is no place for Analysis by the Averted Glance. It is a place for comprehensive hypotheses, critical analyses of field data that inevitably are incomplete, and sound testing whereever possible in the laboratory by the proven methods of science. Naturalists shouldering some of the difficult and still-needed field work will continue to make an important contribution.

There is no question that we will all some day reach the third stage in the Huskins syndrome. But one wonders if there will be a Peregrine Falcon surviving on the North American continent when the agricultural chemical industry finally reports, "Hell, we knew it all along."

JOSEPH J. HICKEY
Department of Wildlife Ecology,
University of Wisconsin, Madison, Wis. 53706

Great Moments in Action

The Story of the

Sun Life Falcons

PHOTOGRAPHS BY THE AUTHOR

by G. Harper Hall

FIGURE 1. Peregrine Falcon

Preface to the Reprint

The Canadian Field-Naturalist is very pleased to be able to reprint the modern classic "Great Moments in Action" by G. Harper Hall. The original booklet was published in 1955 by Mercury Press, Montreal. The importance of Mr. Hall's observations stems from the fact that they represent one of the first documented studies of reproductive failures of a species caused by the widespread accumulation of man-made pollutants in the environment. Of importance also is the fact that the observations were made by a naturalist and at a time when pollution was not yet considered to be a serious threat to many of the world's wildlife. Ironically, the particular Peregrines that Mr. Hall watched had adapted very well to living in the heart of a large city.

In 1949, Mr. Hall noted that the female Peregrine Falcon nesting on the Sun Life Building at Montreal ate one of her eggs. Between 1948 and 1952 many eggs disappeared, one embryo died in the shell and one chick also died. These observations posed a mystery to Mr. Hall when he wrote the paper reprinted here, but in the perspective of subsequent research they acquired a considerable significance. In a detailed study of a similar mysterious disappearance of Peregrines in Britain, Ratcliffe between 1967 and 1970 documented observations of 61 depleted clutches in Peregrine eyries. The crash in British Peregrines occurred between 1949 and 1968. Egg disappearance and egg eating by the parent birds was also a characteristic feature of the population decline in Great Britain. Most eggs laid by Peregrines after 1946 in both Britain and North America were found to be thin-shelled. According to J. J. Hickey and D. W. Anderson of Wisconsin, the average reduction in the index of shell-thickness in Peregrines was 19.1% in Great Britain and 18.8% in California.

The cause of the thin egg shells has now been clearly established; it is due to the ingestion of sublethal amounts of pesticides such as DDT and dieldrin which became increasingly widespread pollutants in the earth's biosphere soon after manufacture and large scale use began in the years following the second world war.

In the past 15 years, scientists have found that various kinds of man-made substances are accumulating in the tissues of living organisms, including man, and that, depending on species, kind of pollutant, and circumstances, the effect on the species frequently includes loss of the ability to reproduce. While the situation in the Peregrine is now relatively well understood, only a tiny fraction of the thousands of other species accumulating toxic chemicals is being studied.

The Peregrine Falcon is the first world-wide species to plummet toward the kind of extinction caused by pollution. As such the Peregrine is fast replacing the Passenger Pigeon and the Great Auk as the symbol of man-caused extinction. The examples of the Great Auk and the Passenger Pigeon led to effective legislation to prevent such extinction by direct human predation. Perhaps the Peregrine Falcon example may lead to legislation that will prevent extinctions by the indirect stresses of pollution.

A crucial problem now facing mankind is the lack of good laws, both national and international that would prevent the manufacture of substances that become widespread pollutants in the earth's biosphere. Increasingly, the production of such compounds is being viewed as subversive to the long-term interests of man, regardless of who is producing them. But will laws and enforcement come soon enough to arrest or reverse present global trends?

I wish to thank Mr. Henri Ouellet, formerly of the Redpath Museum, McGill University, Montreal, and presently with the National Museum of Natural Sciences, Ottawa, for his help in providing information about the whereabouts of original material and photographs. Thanks also to Mr. J. Leslie Harries, Manager, Historical Records, Sun Life Assurance Company of Canada, Montreal, for sending so many of Mr. Hall's original prints. I am indebted to both the Sun Life Assurance Company and the Province of Quebec Society for the Protection of Birds for permission to reprint this story. Special thanks go to Dr. Robert Risebrough, Berkeley, California, for first suggesting that the Canadian Field-Naturalist reprint Mr. Hall's account of the Peregrine nesting at Montreal. Thanks also to Mrs. Ann Hanes of Ottawa for redrawing the frontispiece and to Justice G. H. Montgomery for writing a biographical sketch of Mr. Hall.

I wish to dedicate this reprint to its author, Mr. G. Harper Hall, a naturalist who in the finest traditions of natural history made a most worthy contribution to our understanding of the life of the Peregrine Falcon.

THEODORE MOSQUIN

George Harper Hall

George Harper Hall, the author of "Great Moments in Action" was born about 1874 in Aberdeenshire, Scotland. He came to Canada as a young man and was for many years employed by the C.P.R. at Montreal, retiring shortly after the Second World War. Despite his advancing years, he remained active until his life was cut short by an automobile accident in September, 1958.

Mr. Hall was a man of many hobbies. He was at one time president of the Montreal branch of the Royal Astronomical Society. He was an expert woodcarver and keen entomologist, and his extensive collection of insects was beautifully displayed in hand-carved drawers.

In his latter years the two activities to which Mr. Hall devoted himself most extensively were bird-study and photography. He was for many years a director of the Province of Quebec Society for the Protection of Birds and was its president from 1947 to 1950. His interest in photography went back to his youth, and his favorite camera for still subjects remained an old-fashioned glass-plate apparatus that he had bought before coming to Canada. His interest in birds led him more and more into taking action shots, and for these he used more modern equipment. He became particularly interested in the gannets of Bonaventure Island and took many fine photographs of these birds in flight.

George Harper Hall

When the nesting Peregrines established themselves on the Sun Life Building, it was natural that Mr. Hall's special interests and talents should lead him to make a detailed study and photographic record of these birds. He had another special qualification, his fearlessness. The birds nested on a cornice projecting high above the street, and most people were happy to view the nest from the inside of a stone ballustrade, but Mr. Hall regularly climbed this and stood on the cornice for his photographs. He was regularly attacked by the female, and on one occasion she knocked off his hat, which floated down into the excavation for the Central Station, not then covered. True to the traditions of his native land, he immediately went down to the station and retrieved his hat from the tracks. When, because of his advanced age, the building management forbade him to cross the ballustrade unless he were accompanied and roped, he was most indignant.

A perfectionist by nature, Mr. Hall took seriously his commission from the Sun Life to write a history of these nesting falcons and entered into correspondence wth ornithologists in many lands. By the time the work was finished, the birds had disappeared. The Sun Life had consequently lost interest, and the work might not have been published had it not been for the intervention of the P.Q.S.P.B.

In his manner, Mr. Hall was gentle and courteous. His qualities of character and intellect won him the affection and esteem of all who knew him.

G. H. Montgomery

July 10, 1970

Preface

The head office of the Sun Life Assurance Company of Canada has been kept in the public eye for the past seventeen years by the unique behaviour of two predatory birds. This story of their adventures has been prepared in response to the request of many ornithologists and scientists, who have written or spoken to me of the desirability of writing a complete and authentic record of observations since the birds first appeared in Montreal.

There are factors in the record that make it altogether unique. It was undoubtedly the first authentic instance of Peregrine Falcons nesting on a man-made structure in a city, although more recently they have been known to nest in other cities on this continent. Nor has there ever been so favourable an opportunity of keeping a pair of this species, in the wild state, under constant and continuous observation for a prolonged period of years.

Finally, this book is a plea for the conservation of this beautiful and noble bird. While not yet a threatened species, the Peregrine is not plentiful, but it is widely distributed. In the past it has been unmercifully persecuted, and even at the present time would-be falconers and egg collectors take a heavy toll. When a bird becomes extinct the world is poorer and the loss irreparable.

I am indebted to the Sun Life Assurance Company of Canada, not only for the favourable facilities afforded of observing the birds throughout the years, but also for their assistance in producing this story.

I must also express my gratitude to the directors of the Province of Quebec Society for the Protection of Birds, for their generous help in publishing this book. Particularly, I desire to thank the President, Dr. M. J. Dunbar of the Department of Zoology, McGill University, who read the manuscript and made valuable suggestions.

G. Harper Hall

The Story of The Sun Life Falcons

A trivial incident sometimes leads to interesting and surprising results. This was undoubtedly true of the two strange birds that appeared in the heart of the city of Montreal in 1936. Not many people were at first even aware of their presence, and not one of those interested anticipated the publicity and furore they were destined to produce. Perhaps no single pair of birds has ever before caused more animated controversy, or been the subject of so many articles, newspaper columns, and editorials from all over the American continent and across the seas. Much that has been written has been foolish and misleading, but the fame of the birds has been far flung and now it is true to say their fame has become world wide.

When the birds made their appearance in the city they were identified by Professor Wynne-Edwards, then of McGill University, and others as Peregrine Falcons (*Falco peregrinus anatum*). On this side of the Atlantic they are more frequently referred to as Duck Hawks, although ducks are by no means their staple food. From the very first they showed a

FIGURE 2. Incubating

decided preference for one of the loftiest and most imposing architectural buildings in the city of Montreal, the head office of the Sun Life Assurance Company of Canada, situated in Dominion Square. They ultimately laid claim to this building for their eyrie, and having established themselves, they never for a single season forsook the site.

FIGURE 3. Guarding the eggs

The Falcon:—The Peregrine Falcon is a magnificent bird. "The most powerful for its bulk that flies", is the verdict of one scientist. For mechanical design, grace and beauty, and many other qualities, it stands supreme among the avifauna.

The female is the larger, and it alone is properly called the "Falcon", measuring 18″ to 20″ in length, with a wing span of 46″. Her mate is termed the "Tiercel" (terms used in the sport of falconry) and measures 15″ to 18″ with a wing span of 42″. The colour of both is very much alike. The breast and underneath parts are beautifully barred with silver grey and brown, the crown is warm brown and the back slatey blue. The tail and primary feathers are barred with grey and brown. The legs and cere (around the nostrils) are brilliant yellow, and the eyes large, dark and shining, with scarcely any visible pupil.

They have no enemies save man and in defence of their young they are bold and fearless, ready to attack any living creature that approaches their eyrie. The Golden Eagle in its relations with man is shy and retiring, and at the approach of danger it will slip off the nest and fly away unobtrusively. The behaviour of the peregrine is very different. Let any one come near the nest when there are eggs or young and she will immediately rise to the attack, and he is foolish who would disregard or underestimate those formidable talons.

Usually they nest on high cliffs on a mountain side facing an expanse of moor or open country, and quite frequently a precipe on the sea shore is chosen, where birds such as the puffin and guillemot are to be found. No attempt is made at nest building; simply a scraped out hollow on a ledge, or even a slightly concave rock serves the purpose, but invariably in very inaccessible positions.

In the light of these facts, it has been a great privilege and opportunity to have those birds nesting in their wild state where, at fairly close range and without undue disturbance, their domestic habits and unique behaviour could be witnessed, and interesting facts gathered about the species.

FIGURE 3a. Incubating. This photograph, part of the Hall collection, did not appear in the original booklet.

From Year to Year:—It was late in the spring of 1936 that the birds were first seen flying around and alighting on the Sun Life Building. The few members of the Bird Society who recognized them to be Peregrines became interested when they remained throughout the greater part of the summer. From the first I had access at all times to the building and also the opportunity, almost daily, of observing their activities from the top floor in the tower of Windsor Station, across Dominion Square.

Fresh interest was aroused when early in April 1937 they again appeared on the building and were kept under observation and photographed. Mention was also made of them for the first time in the local press. Although they remained till late September and pairing was observed, there was no indication of nesting. It is nevertheless possible that eggs were laid on some hidden and inaccessible ledge. This is only a surmise, based on what took place the following year.

They reappeared on March 21st, 1938 and five eggs were discovered in random places, principally in the rain scupper which at that time surrounded the building on the ledge at the 20th floor level. In such a position incubation was impossible as the eggs were at times under water. Yet the birds remained around the building and were last seen on October 25th. The perseverance of the falcons to find a suitable nesting site on the building was very remarkable. Notwithstanding previous failures they returned in the spring of 1939 and tried slightly different tactics. They descended to a lower part of the building and eggs were found behind the pillars at the 17th floor level facing Dorchester Street, where again incubation was impossible.

It was now evident that nesting would be futile unless the birds could find a dry spot on the building equivalent to a "scrape". It was thought by those interested that it would be worth while to try the experiment of a nesting

FIGURE 3b. Incubating (see caption to Fig. 3a).

box, although the species had never been known to use one. Permission was accordingly given by the Sun Life Assurance Company, and early in the spring of 1940 two rough shallow boxes were placed on the ledge at the 20th floor by E. W. Pfeiffer and J. S. Luck. The boxes were partially filled with a mixture of sand and gravel, and placed across the rain scupper, where eggs had previously been laid. All along there has been great confusion in stating the location of the boxes by points of the compass. The building stands on a line running from south-east to north-west, the front facing south-west. The boxes were placed on the two back corners of the ledge over Mansfield Street, one on the north-west corner towards Ste. Catherine Street, and one on the south-east corner at the junction of Mansfield and Dorchester Streets. At first the falcons did not take to the boxes and laid in the gutter. Ultimately they were seen occupying the the north-west box. Then followed a period of strange behaviour moving from one to the other and laying at both sites. Finally they returned to the north-west box, laid two more eggs and settled to incubate. On June 21st two of the eggs hatched and about a month later the two eyases (young) were banded and were seen in the vicinity till the end of December.

Strange comments have come from outside sources to the effect that the Sun Life falcons were semi-domesticated birds kept under management. From 1936 to 1940 the birds were

simply allowed to fly around the building unmolested and their behaviour noted. Eggs were definitely laid in 1938 and 1939 which is surely nesting even if incubation failed. Can the placing of a few rough boards across a water gutter and covering them with gravel, allowing the birds to choose it or leave it, be called management? What is the difference between that and a heap of debris deposited by the wind which formed the scrape, as told by Mr. Horace Groskin, for the falcons on the City Hall in Philadelphia in 1946? ("Auk", July 1952). Without the gravel and the debris, incubation on either building would have been most unlikely. It was now evident that the falcons had taken up permanent residence on the building. Having accepted the nesting boxes they continued to use one or the other every year without exception. After rearing young they did not migrate from the city, and during winter were seen from time to time in the vicinity; frequently towards evening they came in to roost on the building.

The two boxes were left in place throughout the winter and early in March 1941 the birds were in evidence. On the 29th the male was found covering two eggs and on April 4th there were five eggs in the nest. In this latitude the normal time for peregrines to lay is towards the end of April, but frequently the Sun Life birds have had eggs in March and rarely later than the first days of April. Three of the five hatched early in May but only two of the young survived.

About this time contractors were engaged to carry out some repairs on the outside of the

FIGURE 4. Brood of four (1943).

building. As soon as men appeared in the vicinity of the eyrie the falcons met them with loud crying and stooped on them vigorously. The men retreated and refused to work unless the birds were destroyed. This resulted in a great furore, fanned not only by the local press but by newspapers throughout Canada and in the United States, carrying columns about the fierce birds that prevented repairs to the Sun Life Building in Montreal. There was no lack of advice from local people and from outside. One man offered to capture the falcons by a secret falconer's technique he claimed to possess. Letters were sent to Ottawa asking the government to intervene. Telephone calls and letters continued to pour in giving fantastic advice on how to deal with the birds, and falcon clubs in the United States offered to help. One episode occurred when a young man volunteered to show the workmen that the falcons were quite harmless. While the men looked on he approached the birds on the ledge. Immediately the angry female took to wing and struck him with extended talons, lacerating his head and causing a quick retreat with blood flowing. Meantime the Sun Life Assurance Company officials took no part in the controversy but quietly delayed work in the vicinity of the eyrie till after the nesting season, and allowed the storm to subside.

Early in April 1942 the usual clutch of four eggs was laid. During incubation two unaccountably disappeared and it was never known what happened to them, but the other two hatched. On June 29th of the same year there was a mimic bombardment of the building by planes which greatly agitated the falcons. They flew wildly around and then for a day or two were not seen. Their attachment to the building was evident from the fact that they returned and were seen until late in the fall.

The record year was 1943 when for the first and only time the whole clutch of four eggs hatched. Two hatched on May 14th and two on the following day. By June 15th they could fly short distances longitudinally on the ledge. The brood consisted of two males and two females, and all were banded on June 16th.

Aerial Battle:—In 1944 the birds were around early in March and were never absent thereafter. Considerable excitement prevailed about this time due to the intrusion of another pair of the same species. A battle royal raged around the building for nearly a week. Fighting was of daily occurrence between two and sometimes three individuals. On one occasion I witnessed a desperate combat high over and around the building with all four falcons taking part. Ultimately one was found dead on the nesting ledge with part of its breast torn open and part eaten. Professor Wynne-Edwards examined this bird and found it to be an adult tiercel. Now the question arises—was the battle for the site or was it for the female? If we could have identified the sex of the intruders we might have had some clue, but that was not possible.

Fortunately the battle did not prevent but only delayed somewhat the nesting. The first egg was laid on April 13th and, on May 20th, from inside the balustrade, chirping was distinctly heard coming from under the falcon covering the eggs. Thinking the eggs were hatched I went back some distance from the nest and climbed over onto the ledge. Immediately she saw me she stood up and to my amazement the eggs were intact but being now uncovered the chirping was quite loud and I took a photograph of the falcon standing by the eggs and quickly withdrew. One egg at least had hatched by eight p.m. the same day. Of this clutch one died in the shell, three hatched and one of the three died when fourteen days old.

The following year (1945) was an eventful year for the falcons. They appeared as usual in the spring but for some unaccountable reason no eggs were at first laid in the usual place. About the middle of April Mr. Terrill of the Province of Quebec Society for the Protection of Birds telephoned me that eggs had been seen outside an office at the 17th floor level.

Together we visited the office and found the falcon sitting on eggs laid on the huge smooth granite base of a pillar facing St. James Cathedral. This was an impossible place for incubation as the eggs rolled about with every movement of the bird. From an original clutch of

FIGURE 5. Guarding the young — age 5 days

four, three rolled off and were lost, then the site was forsaken leaving one egg. The birds then returned to the original nest on the ledge at the 20th floor level and an egg was laid on May 8th in the north-west box. That happened to be Victory Day and in celebration, showers of papers poured down onto the ledge from the upper windows, and the falcons again deserted. To our delight they came back in two days and on May 14th three eggs were found in the opposite box at the south-east corner. We placed the egg laid on the 8th with the three and incubation commenced. Only one of the four eggs hatched on June 19th, the latest date recorded, and the young chick had a short life. It grew rapidly but crashed on its first flight from the ledge, and although picked up, and fed by the parents, it never recovered the use of one wing.

A New Mate:—Our next surprise was to find that our female had a new mate wearing a band on his leg. Then we realized that the tiercel killed in the fight the previous year was not the intruder, but the original male that appeared in 1936. It would be interesting to know whether this change of mates had any bearing on the erratic behaviour in attempting to nest at the 17th floor level.

For several years after this the falcons continued to nest without interruption. They were elusive during the winter, appearing only at intervals around the building but from early in March they were to be seen daily in the vicinity.

In 1948 I was overseas during the whole summer and on April 5th before leaving the city I visited the ledge and saw the female in the nest and immediately withdrew without flushing her. Eggs were undoubtedly laid as proved by a photograph taken from inside the balustrade by Mr. Richard Herbert of New York, when he was taken up to see the falcons by the superintendent of the building in the month of June, but there was no offspring seen that season.

In the spring of 1949 both birds were seen daily during March, and early in April small pieces of egg shells were discovered in the nest. Then on the 11th, Mr. Cleghorn of the Redpath Museum, McGill University, saw the female eating an egg, thus accounting for the shells previously found. Another egg was laid on the 14th and on the 20th there were four eggs in the nest, but they strangely disappeared one by one. On June 2nd the falcon was sitting in the nest but there were no eggs. Mr. Herbert's photograph proves there had been eggs the previous year and we can only conclude that they disappeared in a similar manner.

In 1950 I took note of very unusual and strange behaviour of the tiercel. He was elusive, rarely came down on the ledge and always kept at considerable distance. It was not till the following spring 1951 that we discovered he was not banded. Without doubt this was a new mate, but when did he join the falcon? It would be interesting if we could solve this riddle. I am

FIGURE 6. Ready to attack

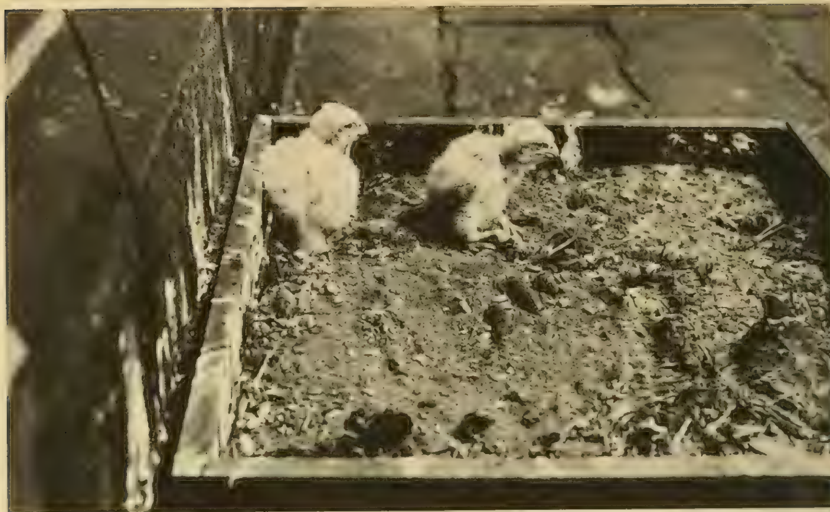


FIGURE 6a. Age 10 days, last brood (1952). This photograph did not appear in the original booklet.

now confident he was with her throughout 1950, perhaps before. After joining her second mate the pair unexpectedly moved away from the ledge to the 17th floor level to nest. Had this third marriage any bearing on the mystery of egg disappearance? I do not know. What puzzles me is the fact that apart from a few small pieces of shell seen in 1949 not a vestige of shell had been seen when the eggs disappeared. If they were eaten by the falcon, did she pick up every particle of shell as well? Perhaps some ornithologist may be able to solve the mystery.

After two years without brood we were naturally anxious to know what would happen this year. Four eggs were laid early in April, one disappeared, but it was a pleasant surprise when all three remaining eggs hatched on May 22nd, and on June 15th the young birds were banded.

In 1951 The American Ornithologists' Union held their annual meeting in Montreal,

FIGURE 7. Age 10 days, last brood (1952)

FIGURE 8. Age 20 days

FIGURE 9. Age 29 days, feathers appearing

FIGURE 10. Age 45 days, fledged for flight

at the invitation of the Province of Quebec Society for the Protection of Birds, and we were anxious that the Sun Life falcons would be on their best behaviour. The usual clutch of four was laid twelve days earlier than the previous year. Unfortunately the tragedy of 1949 was repeated, three eggs disappeared and the fourth was found to be fertile but the chick had been dead for a considerable time.

The birds continued to be a source of interest around the building and in the spring of 1952 the first of a clutch of four eggs was laid within a day of the date of the first egg in 1951. It was again disappointing to find on April 24th that one egg had gone, but the other three hatched on May 7th. Within a few days one chick died but the other two were strong on the wing at the end of June.

It was a keen disappointment when the falcons failed to appear on the building in the

spring of 1953. They had not failed before on a single occasion for seventeen years, and there is little doubt that the female has been killed. Had the tiercel only been lost I am confident the falcon would have returned to the building in the spring. These birds mate for life but if an accident happens to one it is evident they quickly find another mate. An eyrie on a rocky precipice is often taken by another pair when the original owners disappear. Peregrines are frequent visitors to our great cities attracted by the abundant food supply of pigeons. We will therefore hope that another pair may ultimately decide to use the Sun Life Assurance Company's building for their nesting place, and they will undoubtedly, like the first pair, get a lifelong lease.

It is quite certain it was the same falcon that nested on the building for seventeen years, although she had in that time three mates. There was a characteristic dimple among the breast feathers, very clearly seen on the frontispiece photograph, that remained unchanged throughout the successive moults, but was not evident on other falcons I had seen.

Apart from that and other slight identification marks I had noticed, there was infallible proof in the "personality" of the bird. All falcons differ from one another in this respect. Her three mates were first recognized by the differences in their behaviour. After observing closely this Monarch of the Air for so many years in her domestic habits, superb manoeu-

FIGURE 10a. The Sun Life Building, Montreal, showing ledge at upper part where the falcons nested.

FIGURE 11.
A horizontal attack

vres, and lightning attacks, I have no doubt whatever it was the same bird that appeared in 1936 and remained till 1952.

Flight:—The falcons taking up residence in the city over a prolonged period afforded a favourable opportunity not only of studying their domestic habits, but also of witnessing their amazing powers of flight. The form of the streamlined body and tapering wings is characteristic of birds capable of high speed, and gives the peregrine unmatched dexterity in turning and doubling, equal to that of smaller birds such as the swallow or swift. I have watched falcons in flight on the Cairngorm Mountains in Scotland and have seen their marvellous twists and turns in capturing their prey from the sea cliffs of Bonaventure Island on the Gaspe coast, but not till at closer range on the Sun Life Building did I realize the beauty of this marvellous bird, and the amazing speed and accuracy of its every movement. There are birds that are faster in straight flight, some are larger and stronger, but for its size the peregrine is a triumph of flight efficiency.

Many people wondered why they had never seen the falcons come down to pick up a pigeon feeding in Dominion Square. A falcon never stoops to make a kill on the ground. They habitually capture their prey high on the wing, where they can use their speed and momentum to best advantage. Getting into position above the quarry the falcon stoops with terrific speed and impact, grabs the victim, usually by the body, with its powerful talons and breaks its neck with the beak, causing instantaneous death.

Occasionally an old and experienced pigeon will escape by a sudden combined drop in altitude and side swoop just as the falcon's stoop commences, but that is seldom.

The peregrine falcon has been characterized as a savage bird, but that is not true. It is only in defence of her offspring that she is bold and fearless, even in the presence of man, her only real enemy. The tiercel is far less bold, he will stoop and sweep past very close, but while I would not trust him, I have never known him to strike. No one can approach the nest when there are eggs or young without danger from the female. There are several forms of attack. Occasionally she will fly out over the city, turn and swoop in horizontally with wings moving rapidly. This is the easiest to ward off. (See Fig. 11). More frequently she will fly up and up several hundred feet. There is a momentary pause, then, turning in a somersault, first flap-

FIGURE 12. An astonishing evolution

ping vigorously, then with partly outstretched wings, assisted by gravity, she shoots downwards like a thunderbolt at an angle of approximately 45 degrees, straight for her victim. Various estimates have been made of the speed of a "stoop", up to 200 mph. No one really knows, but it is terrific.

One of the most extraordinary manoeuvres is shown in Fig. 12. The falcon was flying longitudinally over Mansfield street and I stood close to the corner, with feet in the gutter and back braced against the wall, ready to take a photograph as she passed. Imagine my surprise when brushed across the face with either the primaries or tail feathers, I could not say which, it was all so quick. She had come along very near to the building and turned at right angles when she saw me. Fortunately I was too close to the corner for the falcon to make an acute turn and reach me with the talons, but the amazing thing was the right angle turn at such a speed. I had with me that day on the ledge Mr. G. Gostwyck who is fearless on heights. Knowing the manoeuvre would probably be repeated I withdrew several yards and knelt on the ledge with the camera, trusting entirely to Gostwyck for a body guard.

He stood close behind me with a stick over my head. The falcon flashed round the corner and was coming straight for us. There was a shout and up went the stick and at the same instant I released the shutter. The bird darted out at right angles and I had no idea what might be on the film. It proved to be an exceedingly

FIGURE 13. Photographer loses his hat

fortunate shot, one that there is little hope of ever repeating. It is in fairly good focus, and shows how the sharp turn was made by bringing all the security devices of the bird into play. There is the simultaneous banking, spreading of the wing and tail feathers, and the operation of the alula (bastard wings) to prevent turbulence on the upper surface of the wing. The exposure was the fastest the camera could give —1/1200 sec. at f.8, and even at that shutter speed there is slight movement.

On either occasion inside the balustrade I stood tightly into a corner of the wall thinking I could watch her movements and defend myself from a front attack. The falcon flew past in front once or twice, then in a few moments I got a heavy blow right on top of the head, flattening my hat over the eyes. Warded off in front she soared and dropped like a plummet close into the corner, the only way possible to strike in that position. It was never safe to go on the ledge without a hat. One day there was no sign of the falcon around and I ventured to photograph the young, when she appeared from

FIGURE 14. A family group

nowhere and struck me on the head from behind. The talons went through the felt and away she went with the hat over Simpson's store trying to shake it off. After a time she got rid of it, and it floated down into Dominion Square. A day or two later I found a cartoon, (Fig. 13), on my desk, drawn by one of the lads in the office.

Photography:—A writer in an American magazine stated that it was easy to photograph the Sun Life falcons as the building had a flat roof. Unfortunately the falcons did not choose to nest on the roof, but on a ledge surrounding the building one hundred feet lower down and exactly three hundred feet from the street level. To get there you take the elevator to the 20th

FIGURE 15. In defence of her young

FIGURE 16. A terrific stoop

floor, climb out of a window, and cross an open space 17′6″ wide to a stone balustrade. This is 6′6″ high and the drop down on to the ledge on the outside is 7′6″. From the beginning I realized that no good photographs could be taken from inside the balustrade. It was only after study of the falcon's habits and manoeuvres that I ventured on the ledge, and still longer before I attempted any flight pictures. To be comfortably safe when photographing the young it was usually necessary to wait till the falcon settled within view, then before an attack she had to rise on the wing for a stoop. She never attacked directly from the ledge. Once when edging up to two young ones about 29 days old, she also edged up from the opposite side and came close to them. I then got a family group minus the tiercel shown in the photograph (Fig. 14).

At another time I had just photographed two "eyases" in the nest while the mother stood on watch at a considerable distance. Then venturing closer I lifted one and immediately she was on the wing, but instead of an attack she pitched beside the one I had to drop on the ledge, and gave me the opportunity to photograph her standing guard over it. (Fig. 15).

Flight pictures were far more difficult to take. The distance had to be determined beforehand and then accurately gauged with the eye, as a smaller stop than f.8 could seldom be used with a shutter speed of 1/1000 sec. or faster. There was also the danger of the falcon's attack. To stand calmly on the ledge and wait till the winged form, descending like a bolt from the sky, was in focus, did require fairly steady nerves. When taking the photograph (Fig. 16), I allowed the falcon to come within

about 30 feet before releasing the shutter. There was then only a split second to wheel and thrust my head, the only part of my body where injury could be serious, between two pillars of the balustrade. Her breast instantly struck my shoulder with a heavy thud and the talons ripped the sleeve above the elbow.

I have been criticized by friends for venturing on the ledge without being roped. Any one affected by dizzy heights has no right there, but heights have never troubled me in the least. Also the ledge is secure, not like a shale precipice any part of which may give way under the feet. Here it is not the height but the attacks from the birds that is the real danger, and against that, a rope dangling from your body would be a decided handicap and a great hazard, especially where quick movement, as mentioned, is required. Any attack must come from the outside, there is therefore no danger of being knocked off the ledge by impact from the bird.

Mortality:—Mortality among young peregrines on montain fastnesses is said to be high. I have been unable to get any statistics of what it is in general but it was certainly high on the Sun Life Building. Omitting the years prior to the birds finding a place where incubation was possible, and also omitting the extra clutch laid at the 17th floor level in 1945, and taking the years 1940 to 1952 inclusive, fifty eggs were laid, 26 hatched, and 22 of the chicks survived to take wing. Hawks usually commence incubation when the first egg is laid and therefore the young do not appear on the same date. On the Sun Life Building it was usual for the young to hatch within a few hours of each other on the same day. The record on page 31 simply gives the period from the date that the first egg was laid to the date they all hatched. The average for that period over the years was 39 days. The egg of the falcon is a warm orange-brown colour, blotched with reddish spots, and measures 2″ in length. In one clutch there was an unusually large egg that did not hatch. It was darker in colour and measured 2-5/16″.

Banding:—As far as possible all the young falcons were banded, but a few did get away without bands. Of those banded there were three returns. The brood of four hatched in 1943 were banded on June 16th. One was shot three miles from Swainsboro, Georgia, U.S.A.

NESTING RECORD

YEAR	FIRST EGG LAID	SIZE OF CLUTCH	DATE HATCHED	NO. OF YOUNG	SURVIVED	DAYS INCUBATION
1938						
1939						
1940	?	4	JUNE 21	2	2	?
1941	MARCH 28	5	MAY 6	3	2	39
1942	APRIL 4	4	MAY 13	2	2	39
1943	APRIL 8	4	MAY 14	4	4	36
1944	APRIL 13	4	MAY 20	3	2	37
THIS YEAR FOUR EGGS WERE FIRST LAID AT THE 17TH FLOOR LEVEL BUT ROLLED OFF, THEN THE BIRDS MOVED UP TO THE USUAL LEDGE AND LAID AS FOLLOWS.						
1945	MAY 8	4	JUNE 19	1	1	42
1946	MARCH 29	4	MAY 7	2	2	39
1947	APRIL 16	4	MAY 26	3	2	40
1948	?	ONLY 1 SEEN		NIL		
1949	APRIL 14	4		NIL		
1950	APRIL 11	4	MAY 22	3	3	41
1951	MARCH 30	4	EGGS DISAPPEARED	NIL		
1952	MARCH 29	4	MAY 7	3	2	39

FROM 1940 TO 1952 — TOTAL 50 EGGS — 26 HATCHED — 22 SURVIVED.

FIGURE 17. Photographing on the ledge

on October 7th of the same year. Another of the same brood was found dead in New York City on Christmas Day, also the same year. A very interesting case was that one of three banded on June 15th, 1950. While still in the city on August 7th, it had already learned to stop and capture its prey. Although only 77 days old it stooped on a full-grown pigeon and seized it in its talons. Inexperience and the terrific momentum of the stoop, plus the weight of the prey, caused a crash on top of the lofty Royal Bank Building that broke its neck. When found, the pigeon was still firmly held in its talons.

Food:—The particular species of birds on which falcons prey depend largely on the locality of the eyrie. It was undoubtedly the food supply that attracted them to Montreal where there is a superabundance of feral pigeons. These and starlings, another abundant species, has all along been the chief food of the Sun Life falcons. They do not kill for sport and every particle of flesh is cleaned off, leaving only the head and legs. Prior to the young hatching, the parent birds lived principally on pigeons but there was generally a great increase of starlings brought in for the offspring. It was remarkable how very few song birds were captured. Occasional victims were redwing black birds, grackles, and nighthawks. Throughout the years I found only one instance of the following, meadowlark, killdeer, and robin.

Like owls and other birds of prey, falcons must eat a certain amount of feathers or fur, to keep healthy, but this is afterwards cast in the form of a pellet.

Correspondence:—It was surprising how news of the Sun Life falcons in Montreal reached far corners of the earth. As might be expected, newspapers and magazines sometimes gave very garbled accounts. Many letters poured in, sometimes offering advice on how to deal

with the birds, but more frequently asking for authentic information regarding them. One bird lover, a boy eleven years old, in a town in Georgia, U.S.A., wrote to the Sun Life Assurance Company as follows. "At the age when the young are old enough, would it be possible to buy one male? If so, mail me the price. Or would it be possible to get a full-grown hawk?, and please write me and tell me how much it would cost." In reply the Company sent him a nice letter explaining that it was impossible to take the birds and we would not want to if we could. With the letter the boy got a very fine enlarged photograph of the female falcon.

Another, of a different type, came to me from the Higashyama Zoo, Nagoya, Japan. The writer, by name Arie Niwa, explained that he was a Japanese bird lover and had read of the falcons on the Sun Life Building. He asked if he could get the story about them and a carbon photograph of the birds. I sent him a photograph along with the Sun Life Review which contained an abridged story. He replied by air mail expressing his gratitude and his delight to have the review.

At the request of Georges Oliver, Elbeuf, France, I sent him photographs of the Sun Life birds, for publication in connection with an article he was preparing on Peregrines breeding on buildings throughout the world. The article has since appeared is L'oiseau et la Revue Française d'Ornithologie, and he has kindly sent me a copy. It is a most interesting account but I am a little doubtful of some of the nesting places mentioned being authentic. Some time ago I made inquiry regarding the truth of the report about Salisbury Cathedral and was emphatically told that Kestrels and not Peregrines had nested there. Also, I think the most unlikely place on earth for a peregrine falcon to nest is on the Tay Bridge in Scotland, a comparatively narrow steel structure over which trains thunder and vibrate every hour of the day and night. Of all places, that one would hold the palm if corroborated.

Immediately the falcons were reported to be nesting in Montreal numerous letters and newspaper clippings poured in, stating that the species had been nesting on other buildings for many years, for instance on the Empire State Building in New York, and The Travelers Tower in Hartford. Doubtlessly peregrines were seen from time to time on those buildings, as they were also seen in Montreal long before they nested, but investigation showed those reports to be without a thread of evidence acceptable in any court of reasonable consideration. At a more recent date, 1944, a pair did establish themselves on the St. Regis Hotel in New York, and in 1945 on a building in 72nd Street, and again on the St. Regis Hotel in 1946, but on every occasion with tragic results.

In 1946 nesting took place on the City Hall in Philadelphia. These facts indicate that peregrines are being more and more attracted to our big cities by the abundant food supply. It is also reasonable to expect that falcons reared on a skyscraper would be inclined to nest in a similar place when they reach maturity.

It is not unlikely that as they become accustomed to the noise and lights of city life, nesting may become more general, provided they are not persecuted.

It is worthy of note how the attitude of the average citizen of Montreal changed towards these remarkable birds during the 17 years they were on the Sun Life Building. At first there was a large percentage of people decidedly hostile, with that strange mentality that seeks the destruction of any rare or beautiful creature that appears in our midst, without any consideration of its value or usefulness. Prior to 1936 a peregrine was shot in the heart of the city. More recently two ospreys and numerous owls have been shot notwithstanding that firearms are forbidden in the city. It is gratifying that the people of Montreal have now a greater regard for the falcon, and on every hand we hear expressions of regret that the Sun Life pair has gone.

Commendation:—Letters of Commendation have from time to time reached the Sun Life Assurance Company of Canada. Among others one came from the National Audubon Society expressing the appreciation of their continent-

wide membership for the protection given to the pair of falcons nesting on the building in Montreal.

The American Ornithologists' Union when they met in Montreal, October 1951, passed the following resolution:—"Resolved, that the American Ornithologists' Union commended the Sun Life Assurance Company for the protection of the Sun Life peregrines and promoting public appreciation of the value of, and interest in birds of prey."

Finally, no less an authority than George G. Goodwin, associate curator of the American Museum of Natural History, New York City, sent a tribute to the Sun Life Assurance Company for their worthy example in the conservation of Wild Life. The following is an extract from Mr. Goodwin's tribute: "It is indeed fortunate that the people of Montreal have a sympathetic feeling for the magnificent pair of falcons that nest annually on the Sun Life Building. While it is true that other falcons have attempted to establish similar residence on the skyscrapers in New York City, their efforts when discovered have resulted in inexcusable tragedy. Despite the pleas and strict laws of the New York Conservation Commission and ardent support of the Emergency Conservation Committee who rank the falcon among the most treasured of our wild life species, pigeon fanciers, leading the unsuspecting public, have branded them as fierce and furious criminals to be destroyed at the first opportunity. This unfortunate state of affairs seems to be existent throughout most of the cities in the falcon range of America, leaving Montreal as the only proud and fortunate exception."

It is only fair to state that the above was written prior to 1946 and in that year a pair of peregrines nested successfully on the City Hall Tower of Philadelphia.

To any lover of wild nature a live falcon is more valuable than many pigeons and it is hoped that the example of protection afforded those splendid birds in Montreal will induce many to admire but not seek to destroy them, whether on a man-made eyrie or one the wild majesty of a mountain precipice.

"The Death of a Rook" From a painting by the celebrated British artist G. E. Lodge

The North American Peregrine Survey, 1970

TOM J. CADE
Cornell Laboratory of Ornithology
159 Sapsucker Woods Rd.,
Ithaca, New York 14850

RICHARD FYFE
Canadian Wildlife Service,
Edmonton 14, Alberta

Abstract. Fifteen regions were surveyed in Canada and Alaska in 1970 to assess the current breeding status of the Peregrine (*Falco peregrinus*) in boreal America. About 237 known eyries were examined, 149 in the range of *F. p. anatum,* 56 in the range of *F. p. tundrius,* and 32 in the range of *F. p. pealei.* In the southern parts of the former breeding range in Canada, including the Maritimes, southern Labrador, southern Quebec, Ontario, Alberta, and Saskatchewan, only four pairs were found at 82 former eyries. An examination of 64 eyries in the taiga of Canada and Alaska yielded 34 occupied sites, and similar studies in the Arctic tundra produced 31 occupied eyries out of 53 examined. Of 32 eyries studied in the range of *pealei,* 23 were occupied. Both tundra and taiga populations have declined locally since 1966. Reproductive success among these northern falcons has diminished in association with eggshells that are 15-20% thinner than they were in these populations before 1947. There is a highly significant negative correlation between chlorinated hydrocarbon residue levels in egg contents (or adult tissues) and the thickness of eggshells. At the current rate of decline, the Peregrine may become extinct in North America in this decade.

The dimensions of a continent-wide population crash of the Peregrine Falcon (*Falco peregrinus*) in North America came into focus at the Madison Peregrine Conference in 1965 (see "Peregrine Falcon Populations, their Biology and Decline," edited by J. J. Hickey, Univ. of Wisconsin Press, 1969). By that year the falcon had already disappeared as a breeding species at all observed eyries (146 locations) in the eastern United States from the Mississippi River to the Atlantic Coast, where once there were more than 200 known eyries. It was not clear just how far northward into Canada the decline of the eastern *anatum* population had extended, but evidently southern Ontario, Quebec, and the Maritime Provinces had been seriously affected. In the Rocky Mountains region, including Alberta, only 33% of all known eyries were still occupied, and it was estimated that in the northwestern states of Washington, Oregon, Idaho, Utah, and the western parts of Wyoming and Montana 80% to 90% of the old, traditional nesting places were abandoned. Although at that time detailed studies had not been made in California, where the Peregrine was once common, enough information was at hand to be certain that a serious reduction in the number of eyries had occurred there too, as well as on the Pacific side of Baja California.

In contrast to these gloomy findings, some studies in Alaska and in northern Canada indicated that the arctic, migrant Peregrines (*F. p. tundrius*) remained vigorous and unaffected by any reduction in numbers, although one local, forest-inhabiting population of *anatum* falcons around Yellowknife had disappeared. The same conclusion appeared to be true for *F. p. pealei,* the maritime population of the Northwest Pacific region.

By 1969 a considerable amount of new fieldwork had been accomplished, and it was obvious that the momentum of the decline had not stopped south of the boreal forests. A second Raptor Research Planning Conference was held at Cornell University on 7-9 November to review the changes that had occurred since 1965.

The reports at this meeting showed that the impact of the decline had extended westward and northward on the continent. Only 20% of 50 eyries in Arizona, New Mexico, Colorado, Wyoming and Montana held falcons, and only 8 pairs were successful in producing young (J. H. Enderson). Only 3 pairs remained in Alberta (R. Fyfe). In California the best information indicated not more than 5 known active eyries and about 3 pairs that laid eggs in a state where there are 91 verified eyries at which Peregrines

used to breed and where possibly as many as 173 sites once existed (S. G. Herman).

Some boreal populations that were thought to be secure in 1965 had also declined. In the Queen Charlottes a local breeding group of *F. p. pealei* had declined from 15 or more pairs in the early 1960's to 5-6 pairs in 1968-69 (W. Nelson). Similarly, a sampled breeding population in the Northwest Territories had decreased by 29% since 1966, and one in the central barrens had declined to 50% of the number present in 1966 (R. Fyfe). In Alaska, a long-studied breeding population of *tundrius* on the Arctic Slope and another of forest-inhabiting *anatum* showed no significant changes in number of occupied eyries, but reproductive success had decreased progressively each year since 1966 and was associated with an increasing percentage of pairs that failed completely (T. Cade).

By the time the Cornell Conference convened in November 1969, the evidence from a variety of sources had become overwhelming that, just as in Britain and Western Europe, the Peregrine Falcons in North America have been victimized by a chemically induced disease caused by hard pesticides of the chlorinated hydrocarbon group, such as DDT and dieldrin, and possibly by other chlorinated pollutants, the polychlorinated biphenyls. While direct adult mortality from lethal levels of residues was probably a factor early in the decline, the most quantifiable symptom of the pesticide disease is the production of thin-shelled eggs. This phenomenon, which is almost entirely unknown in wild bird populations before 1947, has been thoroughly documented for a number of species, including the Peregrine populations of both Great Britain and the United States (D. A. Ratcliffe, *Nature* 215: 208-210, 1967; J. J. Hickey and D. W. Anderson, *Science* 162: 271-273, 1968). The thin eggshells are associated with high residue levels of DDE and other chlorinated hydrocarbons in egg contents or in adult falcons, and shell thinning has been experimentally induced by feeding pesticides to several species of birds. In its extreme expression, shell-thinning is associated with an abnormally high incidence of broken eggs in the nest and with failure of eggs to hatch, and this is probably the main way in which pesticides have effected Peregrine declines.

Faced with these facts, the Cornell conferees concluded that the Peregrine should be officially designated as an endangered species in all of North America, and as previously reported in *The Canadian Field-Naturalist* (vol. 83: 297-299, 1969) letters were sent to the governments of Canada, the United States, and Mexico urging this course of action and to take whatever measures are necessary to preserve the Peregrine from extinction. The petitions were given careful and detailed consideration by both the Canadian and U.S. governments, and recently the U.S. Department of the Interior added *F. p. tundrius* to its list of endangered subspecies along with *F. p. anatum*, but *F. p. pealei* was not included.

The conferees also decided to try to man a continental survey of Peregrine eyries in North America at 5-year intervals beginning in 1970, in order to keep abreast of the continuing changes in population status and reproduction. Cade was asked to organize the surveys, and we divided the continent into study areas, as follows: (1) Greenland, (2) Canada, which was further divided among several field teams under the supervison of R. Fyfe, (3) Alaska, (4) the Rocky Mountains and intermontane western regions of the United States, (5) the Pacific Coast, and (6) Mexico. From the first, funding was a major obstacle. We approached several national and international organizations that should have been interested in the Peregrine. In the end, we were able to mount a dozen field surveys in Canada, primarily through the offices of the Canadian Wildlife Service, five in Alaska, one in California carried out by S. G. Herman with support from the California Department of Fish and Game, one in Mexico by Monte Kirven of the San Diego Natural History Museum, and one in the northeastern United States carried out independently by W. R. Spofford.

It was possible to carry out extensive surveys in 1970 to determine the current status and re-

TABLE 1. — Summary of information on numerical status and reproductive performance of Canadian and Alaskan Peregrine populations in 1970

(a) *Falco p. anatum*

Region	Eyries checked			Adult birds present			Reproductive success				
							Pairs with young		Young in nest		
	Previously known	New	Total	Lone	Pairs	Per cent occup.	No.	% total	Total	Per active nest	Per total pairs
Maritime Provinces, & Southern Gaspé	15	0	15	0	0	0	0	0	0	0	0
So. Labrador	0	2	2	0	2	100	2	100	4	2.0	2.0[1]
So. Quebec	3	0	3	0	0	0	0	0	0	0	0
Ontario	29	0	29	0	0	0	0	0	0	0	0
Alberta & Saskatchewan	32	1	33	1	2	10	1	50	3	3.0	1.5
Mackenzie District	15	1	16	3	6	56	3	60[2]	6	2.0	1.2[2]
Yukon Terr.	14	1	15	1	5	40	3	100[3]	6	2.0	2.0[3]
Yukon Valley, Alaska	19	0	19	?	12+	63	7	58	18	2.57	1.50
Tanana Valley, Alaska	13	1	14	0	7	50	7	100	20	2.86	2.86
Totals or means	140	6	146	5	34	27	23	68	57	2.48	1.69

(b) *F. p. tundrius*

Region	Previously known	New	Total	Lone	Pairs	Per cent occup.	No.	% total	Total	Per active nest	Per total pairs
Int. Barrens	11	0	11	0	4	36	3	75	8	2.70	2.0
Ungava	12	3	15	3	9	80	7	78	12	1.70	1.33
So. Baffin	0	7	7	0	5	71	3	60	7	2.33	1.40
No. Alaska	20	0	20	0	10	50	5	50	10	2.00	1.00
Totals or means	43	10	53	3	28	65	18	64	37	2.05	1.32

(c) *F. p. pealei*

Region	Previously known	New	Total	Lone	Pairs	Per cent occup.	No.	% total	Total	Per active nest	Per total pairs
Queen Charlottes	ca. 15	0	ca. 15	1	5	40	5	100	11	2.2	2.2
Aleutian Is.	0	17[4]	17	2	15	100	11[5]	73	15[5]	2.14[5]	1.36[5]
Totals or means	15	17	32	3	20	72	16	80	26	2.18	1.62

[1]Total success not known, as only one nest examined; one young seen at second nest from below.
[2]One nest not examined and not included in calculating productivity.
[3]Two sites not checked and number of young unknown.
[4]Data are from 1969 (see text).
[5]Eleven nests were examined; two others were active, and four pairs failed.

producive success of the Peregrine in Canada, with funds allocated for this by the Canadian Wildlife Service. Priority was given to planning and implementing the surveys throughout Canada. Areas to be surveyed were chosen on the basis of available historical records of Peregrine nesting, together with available information on areas of suitable habitat

within the known breeding range of the three subspecies. On this basis the Canadian surveys can essentially be divided into (i) "*anatum*" Peregrine surveys; (ii) "*tundrius*" Peregrine surveys; and (iii) "*pealei*" Peregrine surveys.

The "*anatum*" surveys were designed to include most of the recorded breeding range of this subspecies in southern Canada and extended from the Maritimes through southern Quebec and Ontario and west to include Alberta and British Columbia. In addition it was decided to extend the survey for "*anatum*" birds into those areas of suitable habitat in the forested regions of Quebec, southern Labrador, the district of Mackenzie, and the Yukon Territory.

Similarly, the surveys to determine the current status of "*tundrius*" were to be carried out in Ungava and the interior barrens of the Northwest Territories, where population data had been previously recorded. Also, based on a limited amount of data and previous Peregrine nesting, reported prey abundance, and information on the extent of suitable habitat, a third survey was conducted on southern Baffin Island.

Although it was our initial intention to carry out similar surveys along the west coast of British Columbia to investigate the populations of *pealei*, on discussing this with that province we were advised that the province intended to carry out independent surveys to determine the current status and nest success of the Peregrine in British Columbia. The province contracted Mr. Joseph Simonyi to do surveys of both the coastal *pealei* and interior *anatum* Peregrine populations. It is our understanding that these surveys were carried out; however the results of the surveys are not yet available. Consequently with the exception of Langara Island where Mr. Wayne Nelson performed an independent study, surveys of the Peregrine populations of British Columbia were carried out by the province.

It was decided that throughout the Canadian surveys investigators were to make every attempt to visit all previously known eyries, each was to be carefully examined for evidence of falcons, and whenever possible sites were to be climbed and examined for signs of recent or current occupancy. Mode of travel throughout the surveys varied from the use of light aircraft, automobile, trail bike, or boat to walking and was for the most part dictated by conditions in the specific area to be surveyed.

Greenland unfortunately remains an unknown region, but the diminished trapping success and number of sightings of migrant Peregrines on Assateague Island in recent years (R. B. Berry, unpublished report) suggest that all is not well even in this "remote" part of the North American arctic. Further, no systematic surveys were carried out in the intermontane western region of the U.S. this year.

The following series of reports is restricted to the Peregrine populations of Canada and Alaska, the area of North America where most of our remaining Peregrines breed, and includes information on all three subspecies, *F. p. anatum* of southern Canada and the taiga, *F. p. tundrius* in the Arctic, and *F. p. pealei* of the Pacific Northwest coastal regions. Results of other surveys will hopefully appear soon.

Table 1 summarizes the main findings of the Canadian and Alaskan studies. The field teams examined approximately 237 eyries (not all are enumerated in Table 1), 149 in the range of *anatum*, 56 in the range of *tundrius*, and 32 in the range of *pealei*. The surveys clearly confirm the fact that *anatum* is virtually gone as a breeding bird in its more southerly Canadian haunts, just as it is in the United States south of Canada, as pairs occupied only four of 82 eyries in 1970. Even more discouraging for what they portend are the findings from the taiga, where two Canadian and two Alaskan populations, all with well documented historical data, show clear indications of reproductive abnormalities and reductions in the number of occupied eyries in the last three years (Tables 2 and 3). The *tundrius* populations of arctic Canada and Alaska are in a similar, or even more serious, condition (Tables 2 and 5). At least one local *pealei* population in the Queen Charlottes has declined. Of all the populations for which we have assembled data in 1970, only the *pealei*

breeders on Amchitka in the Aleutians give the appearance of normality.

Among the boreal populations, the percentage of known eyries occupied by pairs or adult birds in 1970 ranged from 100% on Amchitka to only 36% in the barrens, and several other populations were down to 50% or less. In order to interpret these figures, we need to know what the percentage occupancy was in pre-DDT times. Unfortunately there is not much information on this point for the regions under consideration. In Britain D. A. Ratcliffe (*Bird Study* 10: 56-59, 1963) provided figures ranging from 84% to 91% for 6 populations in the period 1930-39, while comparable figures for the period 1961-62 ranged from 24% to 88%. At 14 Massachusetts eyries from 1935 to 1942, the occupancy ranged from 71% (10 occupied) to 93% (13 occupied) (A. J. Hagar, in J. J. Hickey, *op. cit.*, 1969). On a stretch of the Colville where 14 distinct "territories" (some including alternate cliffs) were known from 1952 to 1959, Peregrine occupancy ranged from 57% to 71% (T. Cade, *Univ. Calif. Publ. Zool.* 63: 151-290, 1960), while during 1967-69 on a longer portion of river where a total of 44 territories was occupied during the three years, the occupancy ranged from 61% to 75%. Since Peregrine pairs in boreal regions tend to be less site-tenacious than in temperate regions, the percent occupancy of all known eyries is not as meaningful as a simple yearly comparison of the number of pairs present in a given region; but if a survey reveals an occupancy of 50% or less it probably means that the population is declining. The figures summarized in Tables 2, 3 and 5 clearly show downward trends in most of these northern populations, associated with decreased reproductive output of the remaining pairs. The decreased reproduction seems to result mainly from an increase in the number of pairs that fail completely rather than from a decrease in clutch size or brood size of successful pairs.

All surviving North American Peregrine populations that have been examined are affected by the same thin eggshell phenomenon described by Ratcliffe for the depleted population of Britain and by Hickey and Anderson for the virtually extinct falcons of California and the eastern United States. The percent decrease in thickness since 1946 ranges from about 15 to 20% or more for samples from Ungava, Northwest Territories, northern Alaska, interior Alaska, and Baja California to less than 10% for samples from the *pealei* populations of the Queen Charlottes and the Aleutians (D. W. Anderson and J. J. Hickey, paper presented at XVth International Ornithological Congress, the Hague, 1970; T. J. Cade *et al.*, unpublished; R. W. Risebrough and M. Kirven, unpublished). In all cases the degree of shell-thinning is associated with a corresponding degree of organochlorine residue contamination of egg contents: the thinner the shell, the higher the residue level. A decrease of about 20% seems to be the critical range in which significant reproductive failure begins.

Newfoundland and The Maritime Provinces

Nelson Hurry, investigator
(prepared by Richard Fyfe).

An extensive survey of Newfoundland and the Maritime Provinces was carried out by Mr. Nelson Hurry. In particular because of reports of Peregrines in the area during recent years specific emphasis was placed on careful and intensive investigation of the fifteen previously known eyrie locations in New Brunswick, Nova Scotia and the southern Gaspé. In addition the 1970 survey covered most of the potential nesting habitat in the Maritimes and southern Gaspé and included extensive aerial investigation of much of both the east and west coast of Newfoundland, followed by some surface investigation of potential or suspected Peregrine nest sites.

In most instances preliminary aerial reconnaissance was carried out in all areas and was followed by intensive surface investigations by boat and finally spot checks on foot.

The results of the survey were disappointing as no Peregrines were observed, and despite recent reports of the species in the Maritimes no evidence was found of current or recent occupancy at any of the many sites investigated. It therefore appears that the Peregrine is no longer to be found as a breeding bird in the area.

Ontario, Southern Quebec and Labrador

R. S. Gibbon, C. C. Gates, and
S. M. Teeple, investigators.

Although the surveys in Ontario, Southern Quebec, and Labrador were conducted by one crew of investigators, each area will be dealt with separately because of the availability of historical data prior to the survey and the methods by which the surveys were conducted.

Ontario

Prior to the commencement of the field investigations data on a total of 72 eyrie locations of Peregrine Falcons in Ontario were acquired from Mr. Joseph Simonyi and from the Royal Ontario Museum. The checking of old eyrie sites was essentially restricted to two sections of the province: (1) Southern Ontario, south of the 47th parallel, from Lake Huron east to Ottawa but excluding the extreme southwestern portion (the area lying south of the 43rd parallel and west of the 80th meridian); (2) Northwestern Ontario along the shores of Lake Superior west to Thunder Bay and including many of the off-shore islands. One reported eyrie site was also checked at Smoky Falls on the Mallagimi River, and three others were checked on James Bay by Dr. George Peck of the Royal Ontario Museum.

Initial investigations were carried out by aircraft. It was soon realized that much of the "historical" information was unreliable. Owing to time limitations and the area to be covered only those sites where we felt that Peregrines could feasibly nest, or where there was sufficient historical evidence to indicate that they had nested, were visited by boat, automobile, on foot, or by landing the aircraft. In each case several shots were discharged from a 20 gauge shotgun from below the cliff and the area examined with binoculars for any signs of falcons.

Of the 72 sites checked only 26 can be considered as having reliable historical documentation. The results of this study show that all of these eyries are now abandoned, as no active nests were found, nor were there any individual, non-breeding birds seen during the survey. Three other known eyries reported by Dalton Muir of the National Parks Service were not checked in this investigation, but are known by him to be vacant. In 1970 none of the 29 known eyries of Peregrine Falcons in Ontario remain active.

Southern Quebec

Unlike the survey in Ontario, we were able to acquire little in the way of historical evidence of Peregrine nesting sites, except that obtained from Reginald Ouellette, who provided us with two known sites and the possibility of a third. These were all south of the St. Lawrence River, west of Riviere du Loup and south of Montreal. These eyries are now abandoned.

The remainder of the survey in Quebec was conducted on the north side of the St. Lawrence River, east of Quebec City in two main areas, chosen because of the abundance of cliffs and the possibility of nesting sites for Peregrines. These were: (1) the Saguenay River which was checked by boat from Tadoussac to Bagotville; (2) a section of land approximately 100 miles wide and extending from Lac Ste. Anne (65 miles east of Sept-Iles) to Harve St. Pierre and including the river valleys of the Moisie, Manitou, Nipisso, St. Marguerete, Toulnostoac, and Riviere aux Rochers, as well as all of the major lakes. In this region, because the rivers are essentially unnavigable, the investigation was conducted by aircraft.

In spite of the abundance of apparently suitable nesting cliffs for Peregrine Falcons both along the Saguenay River and in the Sept-Iles region, no eyries were found, nor were any birds seen. Although aerial surveys are probably the least suitable method of conducting a census on nesting Peregrines, we believe that if there ever was a population of these falcons in the north shore region of the St. Lawrence River, it has been extirpated.

Labrador

Historical data on the nesting locations of Peregrines in Labrador are fragmentary. Much of our work, then, was essentially an original survey. Aerial surveys were conducted along the coast from Makkovik south to Spotted Island and including the Benedict Mountains. Where possible we landed the aircraft at local fishing

villages and talked with the fishermen, who are familiar with specific areas of the coast and who would perhaps know of the nesting locations of hawks or falcons. All such reports were checked. Approximately 125 miles of the coast line including the off-shore islands were checked.

Two active eyries were located along the coast in this investigation. One contained three eyases and one addled egg, but the total contents of the second were not determined as only one adult and a fledgling were observed.

In general, because of the large area covered in Ontario, Quebec, and Labrador, much of which was done by aircraft, it is quite conceivable that active eyries could have been missed; however, in spite of such a possibility, the population of Peregrines in these regions is extremely low, if not extinct. Along the southern coast of Labrador a few remain and appear to be nesting successfully. We cannot make any conclusions about changes which may have occurred in populations either in southern Quebec or in Labrador, as previous information on the abundance of Peregrines for these areas is insufficient.

We gratefully acknowledge the support of the World Wildlife Fund in the Ontario and Quebec Surveys.

Alberta and Saskatchewan

Richard Fyfe and Keith Hodson, investigators.

As elsewhere in Canada historical data on early Peregrine nest sites in Alberta are fragmentary with a total of only 39 previously known nest sites being obtained through the literature and from personal contact with naturalists, falconers, and egg collectors. These site records do suggest that, with the exception of the southeast corner of Alberta, the species apparently bred wherever suitable nesting habitat was available throughout the remainder of the province. No reliable nest records of Peregrines are available for Saskatchewan.

The 1970 survey consisted of checking out known sites in Alberta, suitable habitat in both Alberta and southern Saskatchewan, and all reported observations of Peregrine Falcons. The usual survey technique was simply to conduct initial reconnaissance flights using single engine fixed-wing aircraft and to follow these with more intensive surface visits. In all instances the cliffs were visited, an attempt was made to locate birds, and where any evidence of occupancy was noted the site was thoroughly investigated.

It is not possible to estimate the total mileage by aircraft, boat and automobile; however it is sufficient to indicate that all major river systems and areas of suitable habitat in southwestern Saskatchewan and throughout Alberta east of the Rocky Mountains were checked. Specifically 32 previously known sites were investigated in 1970, together with five current reports of observations on individual or nesting Peregrines. In 1969 five additional sites were checked which showed no signs of recent occupancy. These were not rechecked in 1970.

Three sites were found occupied in 1970, two with pairs in attendance and the third occupied by a lone adult female. Of these one pair was not successful having lost their nest and its contents in a rock slide late in the season. The second pair successfully raised and fledged three young in a second nesting. This pair laid 4 eggs early in May which disappeared shortly thereafter. The pair subsequently renested, again laid 4 eggs, and although the nest ledge was partially destroyed the pair continued to incubate and successfully fledged three young.

The results of the 1969 and 1970 surveys clearly indicate that the Peregrine Falcon has all but vanished from the Alberta scene.

The District of Mackenzie

Richard Fyfe, Keith Hodson and R. Semeniuk, investigators.

In 1966 two independent investigations in the District of Mackenzie resulted in the location of thirteen active Peregrine eyries presumably recorded for the first time and in the checking of four previously known eyries, one of which was active. Again in 1969 all seventeen sites were investigated, six were found to be deserted, one was occupied by a lone adult, and of the remaining ten pairs six were successful in raising a total of fifteen young birds.

TABLE 2. — Recent changes in number of occupied eyries and breeding success in three boreal Peregrine populations

Year	Total sites investigated	Occupied sites	No. of pairs with young	No. young in nests	Production	
					per successful pairs	per total pairs checked
(a) District of Mackenzie						
1966	17	14	—	—	—	—
1969	17	11	6	13	2.2	1.2
1970	16	9	3[1]	6	2.0	1.2
(b) Interior barrens						
1968	11	6	3	5[2]	—	—
1969	10	5	3	5	1.6	1.25
1970	11	4	3	8	2.7	2.0
(c) Ungava						
1967	14	14	11	23	2.09	1.64
1970	15	12	7	12	1.70	1.33

[1]One site not climbed, therefore success unknown.
[2]The 1968 survey was too early to determine productivity as some birds were still incubating.

In 1970 fifteen of the seventeen sites were checked and one additional pair was located, although the nest site was not found. Nine sites (including the above mentioned new site) were occupied, three by lone birds and the remaining six by pairs. Of the six sites occupied by pairs, only three were known to have produced young, a fourth eyrie which held eggs early in the season remained occupied by a pair of silent adults and appeared to have been robbed shortly before our visit. The production of the three successful nests was seven young raised to fledging or near fledging.

It appears obvious that the Peregrine population in the District of Mackenzie is declining at a fairly constant rate (Table 2). The absence of pairs and the presence of lone adults at former sites suggest a fairly steady attrition of adult birds with little or no recruitment and may well signify the demise of the Peregrine in this area. It is interesting to note that although production per occupied eyrie is low the production per successful eyrie is about normal.

Yukon Territory

John Campbell and R. Rafuse, investigators. (prepared by R. Fyfe)

Investigations in the Yukon Territory were carried out for the most part by automobile, boat, and on foot. Due to time limitations coverage in the Yukon was restricted for the most part to include known eyrie locations in the southern and central regions of the territory.

As elsewhere all nesting cliffs were visited, examined for signs of use by falcons, and where possible climbed and searched for evidence of recent or current occupancy. In all a total of fourteen known nest sites and one new site were checked. Six of these were found occupied, five by pairs of birds, and one by a lone adult. Of the five successful pairs only three were accessible and were found to contain a total of six nearly fledged or fledging young.

The average of two young per pair indicated good production; however the number of previously known eyries which were deserted suggests a sharp reduction in the Peregrine population in the territory.

The Upper Yukon Valley of Alaska

S. A. Temple, J. H. Enderson, and L. G. Swartz, investigators.

The Peregrine Falcon population along a stretch of the middle Yukon River has been censused by a number of investigators over the past 20 years. While the population density and reproductivity of these Peregrines have shown yearly fluctuations, a gradual decline in numbers and breeding success has been evident (Table 3). Cade, White and Haugh (*Condor* 70: 170-178, 1968) and Enderson, Roseneau, and Swartz (*Auk* 85: 683-684, 1968) have shown that breeding individuals from this population carry potentially deleterious amounts of chlorinated hydrocarbons in their body tissues. Correlated with this finding is the laying of significantly thinner-shelled eggs than those of Peregrines from this region in pre-pesticide times (Table 4).

During the 1970 nesting season a census of breeding Peregrines along this stretch of river was made in conjunction with an intensive study of Peregrine nesting behavior. Time-lapse cameras which took photographs at two minute intervals were used to monitor the nesting behavior of seven pairs of Peregrines. This camera surveillance was begun on 7 June, about ten days after laying, and terminated on 23 July, about a week before the young fledged. The results of this study will be published separately. Camera surveillance appeared to have no disruptive effect on reproductive success, since eyries with cameras produced young at a rate identical to those without cameras.

TABLE 3. — Historical data on Reproductivity of Peregrines along the Upper Yukon River.

Year	1951[1]	1966[2]	1967[3]	1968[4]	1970
Total no. of pairs	16–19	17	15+	17	12+
Unproductive pairs	ca. 7/19 (36%)	3/17 (18%)	5/15 (33%)	8/17 (47%)	5/12 (42%)
Tot. young fledged	20+	30	21–23	16	18
Fledg. per total pairs	ca. 1.25	1.80	ca. 1.40	0.93	1.50

[1]Data from Cade (Univ. Calif. Publ. Zool. 63:151-290, 1960).
[2]Data from Cade, White and Haugh (*op. cit.*)
[3]Data from Enderson *et al.* (unpublished data)
[4]Data from Cade *et al.* (unpublished report)

TABLE 4. — Eggshell thickness for Peregrines from Interior Alaska and the Upper Yukon River[1]

Pre-1946		Post-1946	
N	Thickness index[2]	N	Thickness index[2]
20	1.79	14	1.48
$t = 8.09$, $p < .001$			

[1]Data from Cade, Lincer, White, Roseneau, and Swartz (in press)
[2]After Ratcliffe (Nature 215:208-210), Index = wgt in mg/length × breadth in cm.

The data on reproductivity for Yukon River Peregrines in 1970 are shown in Table 3. This year there were fewer pairs than ever before occupying cliffs along the Yukon. Also the percentage of birds which attempted but failed to raise young was quite high, and our observations indicate that this was primarily owing to loss of eggs and failure of eggs to hatch. Pairs that did raise young were generally quite successful, so that the total production per pair was good. This is perhaps a reflection of the favorable weather conditions during the early part of the nesting season, but only 18 young were presumed to have been fledged, a relatively low level of production for this prime Peregrine nesting area.

Our study was supported by a grant from the National Audubon Society.

The Tanana Valley, Alaska

John R. Haugh, investigator.

The following is a report of an investigation conducted along the Tanana River in interior

Alaska. Only casual studies of Peregrines along this river have been made previously.

The Tanana is one of the major tributaries of the Yukon River. It flows over 400 miles through extensive areas of spruce forest in interior Alaska. Brian S. Cade and I made a boat trip over a selected study area of about 300 river miles. Our initial trip was made between 2 and 13 July, and we later checked certain areas of the river a second time between 14 and 20 July. These observations allowed us to gather information at a time when young were in the nests.

All cliffs along the river were checked from below, and rifle shots were fired into inaccessible areas as a means to flush off birds that might be present. Except in the case of small cliffs, where we were confident no falcons were present, we also climbed and walked the top of the cliffs. To reach actual nesting sites, we used a 120 ft. climbing rope and conventional climbing techniques.

Seven pairs of nesting Peregrines were found along the Tanana in 1970 with a total of 20 young, or 2.86 young per pair. One recently dead young was found which had apparently fallen from the eyrie. If this latter is included in the total, the 7 pairs averaged 3.0 young per pair. Working in interior Alaska along the Yukon River in 1951, Cade found the number of advanced young per pair to be 1.67 (*Univ. Calif. Publ. Zool.* 63: 151-290, 1960). Along the Yukon in 1966, the number of advanced young was 2.25 per eyrie for 12 pairs (Cade, *et al.*, Condor 70: 170-178, 1968), and the observed numbers in 1967 were similar (Enderson, *et al.*, Auk 85: 683-684, 1968). Although the young along the Tanana ranged in age from about one week to near the point of fledging, and the figures are not entirely comparable, it is apparent that reproductivity of the Tanana Peregrines in 1970 compares well with that previously observed among Peregrines along the Yukon. If anything, the number of young per successful pair in 1970 must be judged to lie on the high side of the mean number that has been observed among other Peregrine populations in North America.

A trip on the river during the incubation period was not made. It is possible that other pairs may have attempted to nest and, having failed, deserted their nesting sites. From experiences along the Yukon and Colville Rivers it seems likely that at least occasional falcons would remain around the Tanana cliffs when nesting attempts failed. I saw no Peregrines along the river other than those at the 7 occupied sites and, therefore, I have no evidence that other pairs attempted to nest along the Tanana in 1970. There is, however, information which indicates that in the past, Peregrines have nested on at least 14 cliffs in the area surveyed. It is not known whether all 14 sites were ever occupied in a single year. For this reason, therefore, I am unable to ascertain whether the 7 pairs observed in 1970 represent a decline in the population along the Tanana.

The Tanana River is considerably more accessible to recreational enthusiasts and river travellers than are the Colville and Yukon Rivers. During the course of its flow, the Tanana makes numerous contacts with highways and access roads. Nevertheless, travel is generally light upriver from Fairbanks because of the braided, shallow nature of the river and because of occasional stretches of rapids. Between Fairbanks and Nenana the river is not braided, and it flows more slowly. In this area traffic is heavy and may be a factor influencing the presence of breeding falcons along this part of the river. Formerly, at least 3 pairs of Peregrines were known to have nested each year between Fairbanks and Nenana (L. G. Swartz, personal communication). In 1970 no Peregrines nested on these river bluffs, but one pair successfully fledged 4 young from a cliff about one mile inland from a former site on the river. The moving of this pair to a less accessible inland location may have been in response to increasing disturbance along the river. Peregrine eyries which do not overlook water are rare in interior Alaska.

In 1970 several nestling falcons were illegally taken by falconers. Because of the accessibility of the river this is likely to be a problem in future years as well, unless state and federal

agencies increase the rigor of their surveillance.

The number of young per sucessful pair in 1970 indicates that some interior Alaskan Peregrines are still producing well, and this is encouraging. I found fewer pairs of birds than anticipated, but whether this represents a population decline, early nest failures and subsequent site abandonment, or simply over-expectation on my part is not certain. Additional years of observations with early trips during the incubation period would help to answer this question. The trend toward greater use of the Tanana River as a recreational stream, and the continued release of chlorinated hydrocarbons into the environment, especially in the falcon's wintering areas, are both problems faced by the Tanana River Peregrines. The fate of these birds hinges on the rapidity with which men learn to respect their environment and the living things that share it with them.

Our work along the Tanana was supported by the New York Zoological Society. John Burns and Phillip Conner of the Alaska Department of Fish and Game were especially cooperative in helping with the study. I express my thanks to them.

The Oil Pipeline and Peregrines in Alaska

Clayton M. White and James H. Streater, investigators.

There is much concern about the impact of a proposed oil pipeline in Alaska and what the construction of it will do to the wildlife, especially to endangered species such as the Peregrine. We surveyed the route (some 700 miles from Valdez to Prudhoe Bay) for raptorial birds, primarily falcons, from 15 July to 11 August 1970, under contract with the U.S. Bureau of Sport Fisheries and Wildlife. We worked from helicopters. Much of the habitat along the route is not suitable for Peregrines, and only one eyrie was less than two miles from the proposed route. We found six active eyries adjacent to the proposed route, some as much as 5 to 10 miles away. Three unused eyries are also along the route. The Sagavanirktok River furnishes the major Peregrine habitat, and three pairs were found along the river. Judging from our experience on other rivers on the Arctic Slope, six to eight pairs at most may be able to nest along the Sagavanirktok River. We conclude that no eyrie is likely to be physically disturbed by the actual mechanics of pipeline or road construction; *however*, we are deeply concerned about the results of opening up such habitat. Once one road has been built into the area north of the Brooks Range, there will be no end to disturbance and exploitation. We can foresee the construction of several arterial roads to other areas. Hopefully some policy for prudent action will guide the impending exploitation of the Arctic.

Interior Arctic Barrenlands

Richard Fyfe and R. Semeniuk, investigators.

Of all the Peregrine populations which have been investigated in Canada no other has been studied as closely by biologists or for as long a period of time as those nesting along the rivers and on the lakes of the interior barrens. A few of these sites have been known since the late 1930's, some have subsequently been under observation by biologists of the Canadian Wildlife Service more or less since 1951, and a majority of the sites has been checked annually since 1962.

The current survey was carried out with a single engine float-equipped Beaver aircraft, together with a rubber inflatable boat, which enabled us to visit eyrie locations despite generally low water levels.

Four of the eleven previously known sites were found to be occupied by pairs of birds, three of these successfully raising at least eight young to 3-4 weeks of age. One new site was found with three young. No addled eggs were found.

Table 2 shows that the Peregrine population of the interior barrens has continued to decline during the past three years with 1970 being no exception. As elsewhere production by successful pairs was good, the most obvious trend in the area being the gradual yet steady decline in the number of breeding pairs. In most instances the demise of a specific pair has been announced by a complete nesting failure at the site during the final year of occupancy.

Ungava

Daniel D. Berger, Robert W. Risebrough, and Robert B. Berry, investigators (prepared by T. J. Cade).

A region in northern Ungava has been surveyed by several investigators each year since 1967, when D. D. Berger and J. W. Weaver located 14 active Peregrine sites. The two most intensively worked seasons were 1967 and 1970 (see Table 2). In 1970, 15 sites were checked between 25 July and 15 August; 12 of these were formerly known, 3 were new, while 4 previously known eyries were not examined. Of the 15 eyries visited, 3 were occupied by single adults and 9 were occupied by pairs, of which 7 had a total of 12 young and 9 addled or cracked eggs. The high percentage of bad eggs in these nests is noteworthy and fits the general pattern found in other northern Canadian and Alaskan populations in the last three years. By comparison the 14 nests in 1967 contained 34 eggs or young, of which only 5 were addled or broken eggs (D. D. Berger and J. W. Weaver).

With the exception of a single ptarmigan, prey species were limited to small passerines at the 5 eyries Berry examined. He identified remains of Horned Larks, Snow Buntings, and Water Pipits in all these eyries. These passerines were encountered infrequently in individual family groups. They were never observed to pass over water or to leave the sanctuary of rocks and grasses. Thus, the problems confronting a hunting Peregrine in mid-summer in this region appear formidable; and it may be that the reason most eyries are coastal or insular is that such locations offer both adults and fledged young more frequent encounters with spring and fall migrants, which follow shorelines.

Southern Baffin Island

James D. Weaver and James W. Grier, investigators.

Several previous reports have indicated the presence of Peregrines on southern Baffin Island (see review by R. Fyfe in Peregrine Falcon Populations, J. J. Hickey, ed., 1969), but most of these give only scattered observations with general descriptions of locations, little data on reproductive success, and varying impressions about the abundance of Peregrines in the region. We surveyed the area for eyrie sites from 1 July through 8 August, 1970, the period when young eyasses are present and the sites likely to be most conspicuous. Our survey was conducted under contract with the Canadian Wildlife Service, with whom a detailed report has been filed.

During approximately 1200 miles of travel by boat, we located and checked seven eyrie sites and saw one additional Peregrine. Adult Peregrines occupied five of the sites. Two of these sites contained healthy young (three at one site and two at the other) approximately four weeks old when last checked. Another site contained two young that died, one at hatching and one just after. The hatching dates of the dead young occurred during a severe storm with heavy rain and winds estimated at over 30 m.p.h. with the eyrie ledge facing directly into the wind. These hatching dates were also approximately three weeks later than at the two sites with healthy young. The female at the site that failed appeared to be only two years old, as she had a few dark feathers on her breast and brown feathers on her back. Of the other two sites with adults present, one had a fresh scrape that the pair only weakly defended, and the other had a fresh scrape with recently molted adult feathers in the vicinity but no adults were actually seen. At the latter site a freshly constructed but unused Raven nest was situated about thirty feet from the Peregrines' main perch and an old scrape.

Weather conditions during June and July 1970 were not favorable to Peregrine reproduction, with means of daily maxima and minima being the lowest on record for June and well below normal in July. Record amounts of snowfall and days with snow occurred for both June and July, and the ice went out over a week later than average. Cloud cover and precipitation were much greater than normal in July, and prevailing winds during July were S.S.E. rather than N.W. (courtesy Frobisher Bay weather office, records since 1946). Hagar (*in* "Peregrine Falcon Populations", J. J. Hickey, ed., 1969) has previously discussed the vulnerability of Peregrines to poor weather. Such conditions

probably accounted for the death of the two young at hatching and may have been involved in the apparent failures at the other two occupied sites. The presence of the young, possibly inexperienced, female at one site and a Raven nest in the immediate vicinity of another site do not help clarify the picture. Any assesment of the effects of contamination from pesticides and other pollutants awaits analysis of eggshell fragments, dead young, and prey that were collected.

An assessment of the *abundance* of Peregrines on southern Baffin Island is extremely difficult. Previous indications are conflicting; e.g., Soper (*Auk*, 63: 224, 1946) described it as rare and only nesting sparingly througout the region, whereas Macpherson and McLaren (*Canadian Field-Naturalist*, 73: 74, 1959) believed they were more common. We did not find birds at some of the places reported by Macpherson and McLaren (e.g., Dorset Island, Negus Bay), and this could mean a decrease in abundance; however, all of the previous reports are based on only a few observations, and no conclusions on *changes* of abundance can be drawn. It is clear to us that Peregrines were *not* abundant during 1970 in the areas we checked. It is possible that Peregrines are more abundant at the numerous lakes inland from the coast, but significant portions of such areas are logistically impractical, if not impossible, to survey.

In conclusion, the reproductive success of those birds that were found (avg. 1 young/occupied site) is low. In view of the abnormal weather conditions and the small number of observations, this rate may not be alarmingly low; but only a few Peregrines were observed, and regardless of how one views the success rate, the actual number of young added to the population from this region in 1970 was small.

Northern Alaska

John R. Haugh, investigator.

The following is a report of an investigation conducted along a section of the Colville River on Alaska's Arctic Slope. The study area has previously been described by Cade (*Univ. Calif. Publ. in Zool.* 63: 151-290, 1960). Logistic support for this survey was provided by the State of Alaska Department of Fish and Game. Mr. Brian S. Cade assisted with the field work and observations.

Along the Colville we found 5 pairs of Peregrines with young. Peregrines were also found on 5 additional cliffs, but these birds either did not nest or had nest failures prior to our arrival. The mean number of young at the active eyries in 1970 was 2.0. This compares with 2.2 in 1967, 2.6 in 1968 and 1.9 in 1969 (T. J. Cade, unpubished reports to AINA). Since the surveys were made at approximately the same times, these figures are reasonably comparable. While the reproductivity per successful pair in 1970 was about the same as in previous years, fewer pairs of birds were successful in 1970, and only 10 young were still in the nests at the time of our survey. This compares with 22 in 1967, 21 in 1968 and 19 in 1969, for the same stretch of river. The number of young produced in 1970 along the surveyed area was lower than expected, based on previous observations, and most of this reduction resulted from fewer successful pairs rather than from a reduction in the number of young per pair.

Table 5 compares the 1970 nesting success of the Colville Peregrines with nesting success along the same stretch of river in 1967, '68 and '69.

The reason for the poor success of the Peregrines along the Colville is not readily apparent. Severe or abnormal meteorological conditions may have influenced reproductivity by delaying the beginning of the nesting period or by increasing mortality among the young. Delayed nesting is also suggested by the fact that most of the young falcons along the Colville were about a week later in their development than in 1967, '68 and '69. Moreover, our observations that other birds (shorebirds, waterfowl, and passerines) seemed to be fewer in numbers in 1970 than in previous years also lend support to the hypothesis that some widespread environmental factor may have influenced avian reproductivity on the Arctic Slope in 1970. Cade (unpublished observations) noted

TABLE 5. — Peregrine Nesting Success along the Colville River 1967 – 1970

Cliff No.	Number of Young Observed in Eyries During Surveys in Late July and Early August			
	1967	1968	1969	1970
1	1	3	0	1
2	2	1	0	—
3	—	—	1	—
4	—	0	—	—
5	—	0	2	3
6	3	3	3	0
7	3	0	2	2
8	0	0	2	0
9	2	0	—	0
10	—	—	2	—
11	0	0	3	—
12	0	1	2	—
13	1	3,0	0,0,0	0
14	—	—	0	—
15	1	0	0	—
16	—	0,0	0,1,0	2
17	3,4,2	3,3,0	0	0
18	0	4	1	2
Totals	22	21	19	10

(—) = cliff unoccupied by Peregrines.
(0) = pair present; no young.
If more than one pair per cliff, pairs are separated by commas.

large scale mortality among young falcons on the lower Colville in 1969, and he considered a plausible cause to be extended cold weather accompanied by rain and snow during late July and early August.

An alternate explanation for the poor breeding success of the Colville Peregrines in 1970 might lie in the levels of chlorinated hydrocarbon residues which are known to be quite high in arctic falcons (unpublished data collected by Cade and associates). Cade, White and Haugh noted that Alaskan falcons may be perilously balanced near the threshold level of organochlorine residues that initiates dysgenic reproductive behavior and eventual population decline (*Condor* 70: 170-178, 1968). The poor reproductive success of the arctic Peregrines in 1970 may reflect the exceeding of this "threshold level" by a part of the population breeding along the Colville. Since the arctic Peregrines constitute one of the few substantial breeding populations of this species remaining in North America, the 1970 observations give cause for concern. The Colville falcons certainly should be watched closely over the next few years, for the extinction of this population in the 1970's cannot be ruled out.

I would like to thank Dr. Tom J. Cade for allowing me to use previous data collected along the Colville and for his advice on this project. This study was also supported by the New York Zoological Society.

Langara Island, Queen Charlotte Islands

R. Wayne Nelson, investigator

The production of 11 flying young from six occupied sites on Langara Island (an average of 1.83 flying young per occupied site) is probably the greatest number since the early 1960's (Table 6). With some shifting of the actual cliffs or ledges used, it appears that the same areas have been occupied for a number of years now, at a somewhat stable, reduced level from that observed in the mid-1950's (F. L. Beebe, *Condor* 62: 145-189; 1960), which was about 15 eyries. The decline on Langara resulted from the disappearance of some breeding pairs in the Cloak Bay area as well as pairs in other areas on the island. The presence of two first-year females in the six pairs in 1969, and the single adult at one site in 1970, are definite suggestions that the turnover rate of adult falcons is rather high, certainly higher than one would expect in a "natural" situation.

In general it can be said the Peregrine Falcons on Langara Island experienced an improved year, especially as concerns their production of young. On the other hand, the seabird situation, which ultimately affects the falcons greatly, does not appear at all good, and some very drastic changes in numbers appear to have occurred in recent years.

TABLE 6. — Occupancy and productivity of Langara Peales Peregrines

Year	Occupied sites[4]	No. of successful pairs	Young fledged	Prod. per successful pair	Prod. per total Occupied
1968	5	3	6[1]	2.0	1.2
1969	6	3[2]	6	2.0	1.0
1970	6[3]	5	11	2.2	1.8

[1]Total number fledged in doubt, 6 young known to have fledged; 3 believed to have been poached.
[2]2 pairs contained immature ♀♀ which apparently did not lay.
[3]1 site occupied by a single adult.
[4]Based on a survey of all known sites on the island.

The Aleutian Islands

Clayton M. White, investigator.

This report summarizes the first detailed study of Peregrines in the Aleutian Islands, Alaska. The studies were made on Amchitka Island, which is situated in the North Pacific between 51° and 52° N. Lat. and is an island of treeless tundra. I observed nests from May to July in 1969 and from mid-May to mid-June in 1970.

Fifteen pairs and two apparently unmated adults defended shoreline territories in 1969. Mean distance between pairs was about 5.3 straight-line miles. In 7 nests, examined during the incubation period, clutch size averaged 3.14 eggs. Nesting success could be determined at only 11 eyries, which fledged 15 young or about 1.36 per nest. Most observed nestling mortality was apparently caused by human activity.

Young began flying near the end of June, and there was near synchrony in dates of leaving the nests. Where nest loss occurred there were no renesting attempts.

About 75% of the prey, May through July, was small alcids of five or perhaps six species. Land birds became more common as prey shortly before the young flew and during the fall, according to the observations of others.

In 1970, 19 cliffs were occupied by adults although two were being held as territories by apparently single birds. Data on nest contents could be obtained from only 13 nests. At one nest one egg was laid and the nest then deserted. The remaining 12 nests contained an average of 3.41 items (eggs or young) in mid-June. I left the island before fledging success could be determined.

Extrapolations from Amchitka population density, from ecological similarities between Amchitkan and other marine Peregrine populations, and from the physiography of the islands suggest that 300 breeding pairs could inhabit the Aleutian Chain. Whatever the actual figure, there is no doubt that the Aleutian Islands provide one of the last remaining strongholds for this species on the North American Continent.

This study was supported by the Atomic Energy Commission through contract to Batelle Memorial Institute.

Epilogue

Many of us like to think there are vast stretches of Canada and Alaska that are still pristine, undisturbed wilderness, providing a haven in which Peregrines can thrive indefinitely. It is sad and frustrating to come to the realization that for all their magnificent appearance of unspoiled beauty, our boreal forests and tundras are chemically polluted environments, at least as far as the Peregrine is concerned. Indeed, the world is a chemically polluted environment. These persistent chlorinated chemicals, which have a worldwide distribution more ubiquitous than that once enjoyed by the Peregrine itself, constitute a perturbation of the environment to which the falcons cannot make adaptive responses. And so the Peregrine continues to disappear at a rate that could bring it to extinction in North America in this decade.

Received October 30, 1970
Accepted October 30, 1970

Organochlorine Pollutants in Peregrines and Merlins Migrating through Wisconsin

ROBERT W. RISEBROUGH
Department of Nutritional Sciences
Institute of Marine Resources
University of California
Berkeley, California 94720

GREGORY L. FLORANT
Laboratory of Ornithology, Cornell University, Ithaca, New York

DANIEL D. BERGER
1328 N. Jefferson
Milwaukee, Wisconsin 53202

The discovery that the Peregrines (*Falco peregrinus*) breeding in the eastern Arctic are laying thin-shelled eggs and are showing symptoms of reproductive failure (Berger *et al.*, this issue) suggests that this population is beginning to be affected by the same extinction process that has resulted in the extirpation of breeding Peregrines in many areas of North America and Europe (Hickey,1969; Ratcliffe, 1970). The Peregrines of the eastern United States disappeared before the nature of the extinction process was evident, but subsequent research showed that eggshell thinning had been associated with the population decline (Hickey and Anderson, 1968). In Great Britain there was a considerable amount of evidence that excessive mortality of adult birds had been a major reason for the rapid decline that began around 1955, coinciding with the introduction of highly toxic insecticides such as dieldrin into agricultural use (Ratcliffe, 1963; Jefferies and Prestt, 1966). The surviving birds, however, experienced reproductive failures that were characterized by shell thinning, egg breakage, and eating of the eggs by the adult birds (Ratcliffe, 1967; Ratcliffe, 1970). Although embryonic mortality may be contributing to the decline in reproductive capacity of the Ungava Peregrines (Berger *et al.*, this issue) the pattern of egg breakage associated with shell thinning now observed in this population appears to be identical to the symptoms noted previously in southern Canada (Hall, this issue), the United States (Hickey and Anderson, 1968) and Great Britain (Ratcliffe, 1970).

At the conference convened in Madison, Wisconsin, by J. J. Hickey in 1965 to examine the causes of disappearance of the Peregrine from the eastern United States, all conceivable factors were considered in detail. Among these, only environmental pollution was consistent with the pattern of extinction observed in Peregrine populations in both Europe and North America (Hickey, 1969). Since reproductive failure now appears to threaten the survival of the Arctic populations, it has become imperative to determine more precisely the particular pollutants responsible.

In addition to the evidence relating excessive adult mortality to the use of several of the more toxic of the chlorinated hydrocarbon insecticides, Ratcliffe (1970) has accumulated a considerable amount of data relating the shell thinning among British birds of prey to the environmental distribution of organochlorine pollutants, including both insecticides with their derivatives and industrial compounds. The latter consist primarily of polychlorinated biphenyls which have become widespread and locally abundant pollutants (Jensen *et al.*, 1969; Koeman *et al.*, 1969; Risebrough *et al.*, 1968). Other pollutants that might be contributing to the decline of the North American Peregrines include mercury and lead. Mercury

is more widespread in the environment than was previously suspected (Fimreite *et al.*, this issue). Waterfowl may accumulate lead from ingested shotgun pellets (Bagley and Locke, 1967) and Peregrines preying upon them might acquire dangerous concentrations. There is as yet, however, no evidence that links either metal at environmental concentrations to the shell thinning phenomenon. Proof is rapidly accumulating, however, that one or more of the chlorinated hydrocarbons, particularly the DDT compound DDE, may induce shell thinning under both environmental and experimental conditions (Hickey and Anderson, 1968; Porter and Wiemeyer, 1969; Heath *et al.*, 1969; Anderson *et al.*, 1969). Very small concentrations of DDE are associated with significant changes in shell thickness in eggs of the Brown Pelican (*Pelecanus occidentalis*) (Risebrough, Anderson and Schreiber, unpublished observations). The role of DDE and of other chlorinated hydrocarbons found in the environment such as dieldrin and the polychlorinated biphenyls in producing additional sublethal effects that might interfere with reproduction is as yet unclear. Delayed breeding or abnormalities in behaviour could be associated with the high rate of steroid degradation caused by the liver enzymes induced by these compounds (Jefferies, 1967; Peakall, 1970). The volume that emerged from the 1965 conference in Madison (Hickey, 1969) concludes with the statement by Hickey and Roelle "How much industrial pollutants like the polychlorinated biphenyls have also contributed to some of these phenomena promises to be an absorbing chapter in the research of the immediate future" (Hickey and Roelle, 1969). The present paper reports on the polychlorinated biphenyls and other chlorinated hydrocarbons in fat biopsy samples obtained from ten Peregrines and seven Merlins (Pigeon Hawk, *Falco columbarius*) trapped at the Cedar Grove Ornithological Station on the western shore of Lake Michigan during the fall migrations of 1968 and 1969.

Materials and Methods

All of the Peregrines were immature birds of the year and therefore approximately three months old. Seven were biopsied in 1968 and three in 1969. All of the Merlin samples were obtained in 1969. Three were adult males, one an adult female, and the remaining three were immatures of the year.

The biopsy technique has been described previously (Enderson and Berger, 1968). There have been no indications that this procedure harms the birds in any way. Biopsy samples have been obtained from Harriers (*Circus cyaneus*) that have been observed for many months afterwards (Frances Hamerstrom, personal communication).

The adipose tissue biopsy samples were frozen, either in acetone-washed glass vials capped with aluminum foil, or in sterile packets lined internally with aluminum foil which are used in medicine for antiseptic gauzes. The samples were weighed in the laboratory to obtain wet weights and then ground in a Waring blendor with anhydrous sodium sulfate. Lipids were obtained by soxhlet extraction for at least six hours with a hot mixture of two parts of hexane and one part of acetone. The organic solvents were removed by evaporation. When small amounts of sodium sulfate were carried over into the extract, the lipid was dissolved in petroleum ether and washed with water.

The biopsy samples were small. The Peregrine samples averaged 0.49 grams, with a range from 0.0496 to 0.983 gm, and the Merlins averaged 0.162 gm, with a range from 0.0497 to 0.5608 gm. Some samples were found to consist mainly of connective tissue rather than lipid. The Peregrine samples consisted of an average of 69% by weight of extractable lipid, with a range from 31% to 91%. One Merlin sample consisted of only 5% lipid, the average percent lipid among the Merlin samples was 35%, and the highest value was 68%.

The lipid extracts were dried at 65° for 8-12 hours, weighed in the beakers, dissolved in hexane and divided into one or more aliquots. The aliquot analysed for the DDT and PCB compounds was passed through a modified Davidow column (Stanley and LeFavoure, 1965). This column, consisting of celite, sulfuric acid and fuming sulfuric acid, permits rapid cleanup with quantitative recov-

eries of the DDT compounds and PCB. Although not an important factor for the present study, it permits much larger amounts of lipid material to be treated at one time than does the florisil method. This procedure, however destroys dieldrin and to determine this compound another method must be employed. Another aliquot of the lipid extract, in hexane, was partitioned twice with acetonitrile, the combined acetonitrile fractions were evaporated to dryness, redissolved in petroleum ether, and applied to a florisil column. The column was rinsed first with 200 ml of petroleum ether and 200 ml of 6% ethyl ether in petroleum ether. Dieldrin was eluted by passing 200 ml of 15% ethyl ether in petroleum ether through the column. Controls had indicated that 90% or more of the dieldrin applied to a florisil column eluted in this fraction.

Blank samples consisting of redistilled petroleum ether analysed through the entire procedure showed no substances that might interfere with the determination of any of the chlorinated hydrocarbons reported here.

The extracts were analysed with a Microtek gas chromatograph equipped with a tritium and a nickel-63 electron capture detector. Glass columns were used containing 3% QF-1, or a mixture of 3% QF-1 and 10% DC-200, on Chromosorb W, 80-100 mesh, acid washed and HMDS treated.

Other laboratories (Reynolds, 1969; Armour and Burke, 1970) have developed methods for separating the polychlorinated biphenyls from some or all of the chlorinated hydrocarbons of insecticide origin. The polychlorinated biphenyl compounds emerge at different times from the gas chromatograph and occasionally a peak may coincide or interfere with the peak produced by one of the insecticides. We have found it possible, however, to quantify PCB, DDE, p,p′-DDD, p,p′-DDT, dieldrin and endrin on the basis of the procedure outlined above, without any attempt at separating the PCB. Dieldrin and DDE emerge at exactly the same time on the DC-200 column, but on the QF-1 column there is no significant interference between dieldrin and DDE, or between dieldrin and any of the polychlorinated biphenyls encountered in environmental samples. DDE frequently constitutes 90% or more of the DDT compounds present in wildlife. The electron capture response of DDE is considerably greater than that of PCB, and although one of the PCB compounds emerges at approximately the same time as DDE, the error introduced in the DDE determination is less than experimental error even when the total PCB concentration is up to five times that of the DDE. Vermeer and Reynolds (1970) have commented upon the difficulty in separating the DDT compounds p,p′-DDD and p,p′-DDT from PCB. On the DC-200 column, both DDT compounds emerge at approximately the same time as a PCB peak (Anderson *et al.*, 1969). On the QF-1 column, however, there is no interference between p,p′-DDT and any of the polychlorinated biphenyls usually encountered in environmental samples.

Although many different chlorinated biphenyl compounds are released into the environment, relatively few persist in the higher levels of food chains. Moreover, these are found in approximately the same proportions in environmental samples over wide areas of the world. The chromatograms of the PCB compounds in the Peregrines analysed in the present study are therefore similar to the chromatograms of Peregrine extracts from Mexico, California, and Amchitka Island (Risebrough, unpublished results). Moreover, the chromatograms are similar to those obtained from extracts of Brown Pelican eggs from several areas in both North and South America (Risebrough, unpublished results). It is frequently possible, therefore, to treat the PCB mixture as a single compound and to obtain accurate relative concentrations of PCB using any one of the several peaks. The peak emerging at the same time as p,p′-DDD on the QF-1 column is almost always of the same height as two of the other peaks. It is therefore possible to obtain a crude estimate of the DDD present without initial separation of the PCB. This assumption may be tested and the identification of p,p′-DDT and p,p′-DDD confirmed by saponification (Anderson *et al.*, 1969; Risebrough *et al.*, 1969). An aliquot of the

extract, in hexane or petroleum ether, is refluxed in 5% KOH in ethyl alcohol. The hexane is then separated from the alcohol and potassium hydroxide by the addition of water and a sample injected into the gas chromatograph. The procedure converts both DDT and DDD to their respective ethylene derivatives, DDE and DDMU, but leaves the PCB profile of the chromatograms unchanged.

Since the profile of the PCB peaks was similar, but not identical to the profile observed in chromatograms of the commercial preparation Aroclor 1254, PCB was quantified by comparing the total area of the PCB peaks emerging after DDE with the areas of the same peaks in chromatograms of standard Aroclor 1254. The procedure is therefore arbitrary, but permits the determination of relative amounts of PCB within the correct order of magnitude of absolute amounts. Moreover, the values obtained can be readjusted as methodology is improved.

Results and Discussion

Enderson and Berger (1968) have previously reported on the chlorinated hydrocarbon residues found in biopsy fat samples from immature Peregrines that were also trapped during fall migration at Cedar Grove, Wisconsin. These samples, analysed by the Wisconsin Alumni Research Foundation in Madison, Wisconsin, contained an average concentration of 19.4 ppm of DDE on a lipid basis. DDE concentrations in the fat of females at the Arctic breeding grounds are much higher, in the order of 300 ppm or higher (Berger *et al.*, this issue).

The ten Peregrine samples analysed in the present study contained 17.9 $\pm$ 12.3 ppm DDE, 0.23 $\pm$ 0.34 ppm p,p′-DDD, 0.71 $\pm$ 0.68 ppm p,p′-DDT, 18.8 $\pm$ 12.5 ppm total DDT (DDE + p,p′-DDD + p,p′-DDT), and 52.2 $\pm$ 32.3 ppm PCB. Seven samples were analysed for dieldrin, which averaged 0.40 $\pm$ 0.64 ppm. All residues are expressed on an extractable lipid basis, with the 95% confidence limits of the standard error of the mean. The values for p,p′-DDD and p,p′-DDT are lower than those previously reported by WARF, Inc., presumably a result of interference by PCB in the earlier determinations (Anderson *et al.*, 1969). The dieldrin values are equivalent to those previously reported and there is no significant difference in the DDE concentrations. On a lipid basis, the average values reported by WARF, Inc. were 19.3 ppm DDE, 0.8 ppm DDD, 1.2 ppm p,p′-DDT and 0.3 ppm dieldrin (Enderson and Berger, 1968).

First year immature Peregrines migrating from the Arctic have therefore low residues of DDE. Unfortunately little is known about the relationships among dietary levels of DDE and PCB, equilibrium concentrations of these compounds in various tissues, and the times required to achieve an equilibrium concentration. The low concentrations found in these Peregrines presumably reflect therefore both the age of the birds, which possibly has not permitted them to accumulate the high concentrations found in adults, and lower levels of contamination found in some of the prey species. An understanding of the pharmacodynamics of DDE and PCB in birds is one of the conspicuous deficiencies in our knowledge in the field of pollution ecology.

Within several ecosystems so far studied, the concentrations of DDE in birds tends to parallel the concentrations of PCB. The ratio may be approximately one to one, as in San Francisco Bay (Risebrough *et al.*, 1968). DDE is several times more abundant than PCB in several Pacific marine ecosystems (Risebrough *et al.*, 1968), but in Florida, PCB is approximately three times as abundant as DDE in the Brown Pelicans (Risebrough, Gress, Anderson and Schreiber, unpublished manuscript). The correlation coefficient between the DDE and PCB concentrations is frequently highly significant. These observations have suggested that the ratios observed reflect the local fallout pattern of the DDT and PCB compounds, and that the DDE and PCB show similar patterns of accumulation, concentration and excretion in the birds and possibly other members of the ecosystem.

Among the 10 Peregrine samples analysed, PCB was more abundant than DDE by approximately three times. The correlation co-

efficient is 0.8897, which is significant at the 0.001 level. Although it is not known from which area of the Arctic these birds have come, the results suggest that over a considerable area of the tundra ecosystems occupied by the Peregrines, this ratio reflects the local fallout pattern of DDE and PCB.

The four adult Merlins averaged 302 ppm DDE (139-704) in the lipid fraction. This value may be compared with an average concentration of 392 ppm in the lipid of 9 breeding Peregrines from the Mackenzie River region (Enderson and Berger, 1968), 725 ppm in the fat of four adult Peregrines from Alaska (Cade *et al.*, 1968) and 334 ppm in the lipid of 9 adult Peregrines from Ungava (Berger *et al.*, this issue). Merlins therefore may possess almost the same level of contamination as the Peregrines and might therefore be expected to show symptoms of shell thinning. The concentrations of total DDT in the adult Merlins averaged 314 ppm. 96% of the DDT residues in these Merlins therefore consisted of DDE. The PCB concentrations averaged 196 ppm (44-467). The samples were not analysed for dieldrin.

In the three immatures, DDE averaged 49.3 ppm (10.8, 18.6 and 119.3), total DDT averaged 50.3 ppm, and PCB averaged 28.6 ppm (5.7, 29.0 and 51.2). With the exception of one immature Merlin that contained 18.6 ppm DDE and 51.2 ppm PCB, a ratio similar to that found in the Peregrines, all other Merlins contained more DDE than PCB. With the one immature excepted, PCB was significantly correlated with DDE ($r = 0.9820$, p less than 0.001, four degrees of freedom). Most of the Merlins, therefore, appear to be coming from a region of the boreal forest where the pollutant fallout pattern is different from that in the tundra ecosystem occupied by the Peregrine.

When PCB was found to be present in Peregrines, occasionally in high concentrations, it seemed likely that these pollutants were contributing to the reproductive failures associated with population decline (Risebrough *et al.*, 1968). The dominant symptom of reproductive failures of the Peregrines in Britain has been shell thinning associated with egg breakage, disappearance of the eggs, and eating of the eggs by the adult birds (Ratcliffe, 1970). In the Ungava population of Peregrines in the eastern Arctic, shell thinning and egg breakage are now contributing to reproductive failures (Berger *et al.*, this issue). The evidence available to date suggests, however, that PCB is not a cause of the shell thinning observed in many populations of birds. No correlation between thinning and PCB was found in the eggs of the White Pelican (*Pelecanus erythrorhynchos*) (Anderson *et al.*, 1969) or in eggs of the Great Blue Heron (*Ardea herodias*) (Vermeer and Reynolds, 1970). An analysis of approximately 200 eggs of the Brown Pelican from both eastern and western North America has shown that DDE rather than PCB is associated with the shell thinning (Risebrough, Gress, Anderson and Schreiber, unpublished ms.) Whenever correlations between PCB and shell thinning have been observed, as in Double-Crested Cormorants (*Phalacrocorax auritus*), PCB is also correlated with DDE (Anderson *et al.*, 1969).

Peakall (1970) has reported that p,p′-DDT delays egg laying in the Ringdove (*Streptopelia risoria*) and that the delay is associated with lower concentrations of estradiol in the blood early in the breeding cycle. Peakall had earlier reported (in Risebrough *et al.*, 1968) that technical DDT, p,p′-DDE, and PCB induce the synthesis of liver enzymes that degrade estradiol, and that PCB is a more potent enzyme inducer than is DDE. Delayed breeding may therefore be one of the environmental effects of PCB, an effect that could be critical to Arctic-breeding birds which must complete their reproductive cycle within a restricted period of time.

A recent investigation in Japan of the "Yusho" or Rice Oil Disease has traced the cause to rice oil contaminated by chlorinated biphenyls (Katsuki, 1969). Both the contaminated rice oil and the Japanese commercial PCB produce symptoms when fed to chicks similar to those observed in the "chick edema" syndrome (Goto *et al.*, 1969). This disease of chicks was first observed in the United States in 1957, and among the symptoms were accu-

mulation of fluid in the pericardial sac and in the abdominal cavity, subcutaneous edema, and liver and kidney damage (Verrett, 1970). Chlorinated dibenzo-p-dioxins have been shown to be one of the groups of chlorinated synthetic compounds that produce this disease (Higginbotham *et. al.*, 1968). These compounds have also been shown to be present in the herbicide 2,4,5-T and induce both mortality and embryonic deformities in chicks at very low concentrations (Verrett, 1970). A similar group of compounds, the chlorinated dibenzofurans, are almost as toxic (Schulz, 1970). These resemble the chlorinated biphenyls in structure and might be derived from them. Whether they are now present in the environment and pose a threat to wildlife promises to be "an absorbing chapter in the research of the immediate future" (Hickey and Roelle, 1969).

Acknowledgements

The research was supported by the National Science Foundation grants GB 6362 and GB 11649.

Literature Cited

Anderson, D. W., Hickey, J. J., Risebrough, R. W., Hughes, D. F., and **Christensen, R. E.** 1969. Significance of chlorinated hydrocarbon residues to breeding pelicans and cormorants. Canadian Field-Naturalist 83(2): 91-112.

Armour, J. A. and **Burke, J. A.** 1970. Method for separating polychlorinated biphenyls from DDT and its analogs. Journal of the Association of Official Analytical Chemists 53: 761-768.

Bagley, G. E. and **Locke, L. N.** 1967. The occurrence of lead in tissues of wild birds. Bulletin of Environmental Contamination and Toxicology 2: 297-305.

Berger, D. D., Anderson, D. W., Weaver, J. D., Risebrough, R. W. and **Reynolds, L. M.** 1970. Shell thinning in eggs of Ungava Peregrines. Canadian Field-Naturalist 84(3): 265-267.

Cade, T. J., White, C. M., and **Haugh, J. R.** 1968. Peregrines and pesticides in Alaska. Condor 70: 170-178.

Enderson, J. H. and **Berger, D. D.** 1968. Chlorinated hydrocarbon residues in Peregrines and their prey species from northern Canada. Condor 70: 149-153.

Fimreite, N., Fyfe, R. W., and **Keith, J. A.** 1970. Mercury contamination of Canadian Prairie seed eaters and their avian predators. Canadian Field-Naturalist 84(3): 269-276.

Goto, M., Sakaguchi, K., and **Ogawa, K.** 1969. Hydropericardium assay of rice oil which caused Yusho and of Kanechlor 400 in Chickens (in Japanese with English abstract). Fukuoka Acta Medica 60: 533-538.

Hall, G. H. 1955. Great moments in action; The story of the Sun Life Falcons. Mercury Press, Montreal (Reprinted in the Canadian Field-Naturalist 84(3): 213-230.

Heath, R. G., Spann, J. W., and **Kreitzer, J. F.** 1969. Marked DDE impairment of Mallard reproduction in controlled studies. Nature 224: 47-48.

Hickey, J. J., editor. 1969. Peregrine Falcon Populations: Their Biology and Decline. University of Wisconsin Press, Madison. 596 pp.

Hickey, J. J. and **Anderson, D. W.** 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science 162: 271-273.

Hickey, J. J. and **Roelle, J. E.** 1969. Conference summary and conclusions, *in* Peregrine Falcon Populations: Their Biology and Decline, J. J. Hickey, ed. University of Wisconsin Press, Madison. pp. 553-567.

Higginbotham, G. R., Huang, A., Firestone, D., Verrett, J., Ress, J., and **Campbell, A. D.** 1968. Chemical and toxicological evaluations of isolated and synthetic chloro derivatives of dibenzo-p-dioxin. Nature 220: 702-703.

Jefferies, D. J. 1967. The delay in ovulation produced by p,p′-DDT and its possible significance in the field. Ibis 109: 266-272.

Jefferies, D. J. and **Prestt, I.** 1966. Post-mortems of Peregrines and Lanners with particular reference to organochlorine residues. British Birds 59: 49-64.

Jensen, S., Johnels, A. G., Olsson, M., and **Otterlind, G.** 1969. DDT and PCB in marine animals from Swedish waters. Nature 224: 247-250.

Katsuki, S. 1969. Reports of the Study for "Yusho" (Chlorobiphenyls Poisoning). Fukuoka Acta Medica. 60: 407.

Koeman, J. H., Ten Noever de Brauw, M. C., and **De Vos, R. H.** 1969. Chlorinated biphenyls in fish, mussels and birds from the River Rhine and the Netherlands Coastal Area. Nature 221: 1126-1128.

Peakall, D. B. 1970. p,p′-DDT: Effect on calcium metabolism and concentration of estradiol in the blood. Science 168: 592-594.

Porter, R. D. and **Wiemeyer, S. N.** 1969. Dieldrin and DDT: Effects on Sparrow Hawk eggshells and reproduction. Science 165: 199-200.

Ratcliffe, D. A. 1963. The status of the Peregrine in Great Britain. Bird Study 10: 56-90.

Ratcliffe, D. A. 1967. Decrease in eggshell weight in certain birds of prey. Nature 215: 208-210.

Ratcliffe, D. A. 1970. Changes attributable to pesticides in egg breakage frequency and eggshell thickness in some British birds. Journal of Applied Ecology 7: 67-115.

Reynolds, L. M. 1969. Polychlorobiphenyls (PCB's) and their interference with pesticide residue analysis. Journal of Environmental Contamination and Toxicology. 4: 128-143.

Risebrough, R. W., Reiche, P., Peakall, D. B., Herman, S. G., and **Kirven, M. N.** 1968. Polychlorinated biphenyls in the global ecosystem. Nature 220: 1098-1102.

Risebrough, R. W., Reiche, P., and **Olcott, H. S.** 1969. Current Progress in the determination of the polychlorinated biphenyls. Bulletin of Environmental Contamination and Toxicology. 4: 192-201.

Schulz, K. H. 1970. Clinical picture and etiology of chloracne. *Reprinted in*: Effects of 2,4,5,-T on Man and the Environment. Hearings before the Subcommittee on Energy, Natural Resources, and the Environment of the Committee on Commerce, United States Senate. Serial 91-60. U.S. Government Printing Office, Washington, D.C.

Stanley, R. L. and **LeFavoure, H. T.** 1965. Rapid digestion and clean-up of animal tissues for pesticide residue analysis. Journal of the Association of Official Analytical Chemists. 48: 666-667.

Vermeer, K. and **Reynolds, L. M.** 1970. Organochlorine residues in aquatic birds in the Canadian Prairie Provinces. Canadian Field-Naturalist 84: 117-130.

Verrett, J. 1970. Statement before the Subcommittee on Energy, Natural Resources, and the Environment. In: Effects of 2,4,5-T on Man and the Environment. Serial 91-60. U.S. Government Printing Office, Washington, D.C.

Received October, 1970
Accepted October, 1970

Organochlorine Residues in Alaskan Peregrine Falcons (*Falco peregrinus* Tunstall), Rough-legged Hawks (*Buteo lagopus* Pontoppidan) and their Prey

JEFFREY L. LINCER
Cornell University, Section of Ecology and Systematics, Ithaca, New York 14850.

TOM J. CADE
Cornell University, Section of Ecology and Systematics, Ithaca, New York 14850.

JAMES M. DEVINE
Syracuse University Research Corporation, Life Sciences Division, Merrill Lane, Syracuse, New York 13210.

Abstract. DDE residues in Alaskan Peregrine Falcons and Rough-legged Hawks were compared with levels in their prey. Based on oven dry (OD) weight, average DDE levels (and standard errors) for Peregrine tissues ($N = 3$) were as follows: egg — 131 ($\pm$ 53.4) ppm; brain — 58.2 ($\pm$ 15.5) ppm; fat — 752 ($\pm$ 225) ppm; muscle — 114 ($\pm$27.6) ppm; liver — 398 ($\pm$ 78) ppm. Based on OD weight, DDE levels for Rough-legged Hawk tissues ($N = 3$ for each tissue) were: egg — 7.07 ($\pm$ 6.57) ppm; brain — 0.67 ($\pm$ 0.48) ppm; fat — 13.3 ($\pm$ 7.58) ppm; muscle — 1.21 ($\pm$ 0.53) ppm. The highest ratio of tissue residues (Peregrine: Roughleg) occurred between brain samples (i.e. 86.9) and muscle samples (i.e. 94.2). Resident Arctic prey contained less than 1 ppm DDE (OD). Tissues of migrating prey, which constitute the bulk of the Peregrine's diet, were represented by two ducks and contained between ten and twenty times more DDE residue (depending on tissue analyzed) than the roughleg prey, resident small mammals.

Introduction

The ubiquitous nature of organochlorine compounds is well-documented. Reports of its presence have originated from such remote places as Antarctica (Sladen, Menzie, and Reichel, 1966) and interior Alaska (Cade, White, and Haugh, 1968).

Many species of birds of prey are experiencing population declines (Ratcliffe, 1963; Ames and Mersereau, 1964; Lockie and Ratcliffe, 1964; Stickel, Stickel and Christensen, 1966a; Hickey, 1969), and at least four meetings have been concerned with them (i.e., Working Conference on Birds-of-Prey, Caen, 1964; International Peregrine Conference, Madison, 1965; Symposium at Wilson Ornithological Society Meeting, 1966; Peregrine Conference, Ithaca, 1970).

It has been hypothesized that organochlorine compounds may be responsible for the observed population declines, since the onset of the declines correlates well with the advent of DDT and other persistent chlorinated hydrocarbon insecticides.

Concentrations of p,p′-DDT plus p,p′-DDD in the brains of birds may be indicative of DDT-induced death (Stickel *et al.*, 1966b, Stickel and Stickel, 1969). Organochlorine compounds are capable of decreasing egg shell thickness and reproductive success (Porter and Wiemeyer, 1969; Heath, Spann, and Kreitzer, 1969) and inducing enzymatic breakdown of various steroids in birds (Peakall, 1967; Risebrough *et al.*, 1968a). In addition, high residues have been associated with declining populations of raptorial birds (Hickey, 1969; Risebrough *et al.*, 1968a; Fyfe *et al.*, 1969).

The Alaskan ecosystem offers a unique opportunity to monitor pesticide residues in Peregrine Falcon (*Falco peregrinus* Tunstall) populations that are not yet decreasing (Cade *et al.*, 1968). It also offers the opportunity to examine residue levels in another Arctic breeding bird, the Rough-legged Hawk, *Buteo lagopus* (Pontoppidan) and the two predators' prey species.

The purpose of our study was (1) to determine the DDE (2,2-bis (p-chlorophenyl) 1,1-dichloroethylene) residue levels in tissue and egg samples of Peregrine Falcons and Rough-legged Hawks from Alaska, (2) to determine DDE residue levels in the predators' prey species,

and (3) to compare residue levels in the avian predators with residue levels in their respective prey species.

In order for pesticide residue data to be most clearly interpreted as to geographical and biological origin, the predators' migrating and feeding habits should be looked at.

Peregrine Falcon

The American arctic-inhabiting Peregrine population of *Falco peregrinus* was given the subspecies name of *tundrius* by White (1968a). This race exhibits the longest migration of all the North American Peregrines. The majority of migrants sighted along the Atlantic seaboard appear to be from the *tundrius* population. Their winter range extends into Central and South America (Enderson, 1965; White, 1968a; White, 1968b). White (1968b) reports that the bulk of arctic migrants that winter in the United States usually do so below 32° N lat.

Seasonal migration into agricultural regions may be more important for some individuals than others. Cade (1960) suggested that some sub-adults may not return to Arctic breeding grounds. This was substantiated by White (1968b), who recorded Peregrines of Arctic origin in South America in June and July. Although Cade (1960) never saw yearlings in Alaska, White (1968b) suggested this may have been because some spent their first summer at the periphery of their breeding range or at least not associated with aerie sites where falcons are commonly sought.

The prey of the Peregrine Falcon is primarily avian. Cade (1960) and Cade *et al.* (1968) reported birds made up approximately 97 per cent of the Alaskan peregrines' diet while mammals made up the remaining 3 per cent.

Rough-legged Hawk

The Rough-legged Hawk's breeding grounds include interior Alaska, and the species winters as far south as California, Arizona, New Mexico and Virginia (American Ornithologists' Union, 1957).

Mice and other small ground-dwelling mammals make up the bulk of the Roughleg's diet. Most studies on the Rough-legged Hawk have revealed that small ground mammals represent approximately 90 per cent of its food (Hausman, 1928; Pearson, 1933; Errington, 1933; Luttringer, 1935; McAtee, 1935; Latham, 1950; Craighead and Craighead, 1956; Schnell, 1967). White and Cade (in press) have reported on the prey found at Rough-legged Hawk nests along the Colville River in Alaska. Microtine rodents made up 74% of the diet in 1967, 87% in 1968, and 80% in 1969. Ground squirrels and birds accounted for the rest.

Methods

Collection and Analytical Techniques

During the summer of 1967, Peregrine Falcons, Rough-legged Hawks, their eggs, and representative prey species were collected along the Colville River in northern Alaska.

Birds were collected either with a shotgun or mist-net. Mammals were captured with snap traps. Field samples were preserved in 10% formalin. Subsequent extraction and clean-up of samples were the same as that described by Cade *et al.* (1968). The limit of detection was approximately 0.01 ppm DDE.

A MicroTek MT 220 gas chromatograph, equipped with a Ni^{63} electron capture detector and three ¼″ × 6′ columns, was used for pesticide quantification. Glass columns were used principally. Metal columns were occasionally utilized and no pesticide breakdown was observed on these. Two of the three columns were used to confirm DDE quantitatively. The third column was used to confirm DDE qualitatively. The liquid phases and solid supports were as follows: 2 per cent of QF-1 on 90/100 Anakrom ABS; 5 per cent SE-30 on 60/80 Chromosorb W®; 5 per cent DC-200 on 60/80 Chromosorb W®. Operating temperatures were: column oven — 190 C, inlet — 215 C; detector — 275 C. The carrier gas used was filtered nitrogen applied at rates ranging from 40 to 80 cc/min., depending on column used and residue separation sought.

Thin-layer chromatography

Approximately 20 per cent of the samples (mostly eggs) were also analyzed for DDE

TABLE 1. — Comparison of DDE residue levels (ppm) in adult peregrine falcon and rough-legged hawk tissues. [means ± standard deviation ($\bar{x}$ ± SD); standard error of the mean (SE)]

Tissue	Peregrine			Rough-legged Hawk			Peregrine: Roughleg
	$\bar{x}$ ± SD	SE	N	$\bar{x}$ ± SD	SE	N	
(a) Oven dry weight basis							
Egg	131 ± 92.5	53.4	3	7.07±11.4	6.57	3	18.5
Brain	58.2± 26.8	15.5	3	0.67± 0.83	0.48	3	86.9
Fat	752 ± 390	225	3	13.3 ±13.1	7.58	3	56.5
Muscle	114 ± 47.8	27.6	3	1.21± 0.91	0.53	3	94.2
Liver	398 ± 135	78	3	18.4 –	–	1	21.6
Ovary	1,117 967	684	2	3.22 –	–	1	347
(b) Wet weight basis*							
Egg	27.4± 22.6	13.0	3	0.92± 1.44	0.83	3	29.8
Brain	10.0± 5.12	2.96	3	0.14± 0.11	0.06	3	76.4
Fat	372 ± 296	171	3	10.7 ± 9.58	5.53	3	34.8
Muscle	28.9± 13.3	7.69	3	0.29± 0.21	0.12	3	99.7
Liver	103 ± 38.1	22.0	3	3.96 –	–	1	26.0
Ovary	152 126	89.0	2	0.25 –	–	1	608
(c) Per cent extractable fat of oven dry weight basis							
Egg	469 ± 336	194	3	41.5 ±67.2	38.8	3	11.3
Brain	246 ± 120	69.5	3	3.34± 3.36	1.94	3	73.7
Fat	964 ± 462	266	3	24.6 ±28.9	16.7	3	39.2
Muscle	1,321 ± 459	265	3	26.3 ±18.7	10.8	3	50.2
Liver	10,900 ±1,030	595	3	357 –	–	1	30.5
Ovary	4,374 –	–	2	13.9 –	–	1	315

*All ppm (WW) data were derived from actual wet weights taken in the field with the exception of one Peregrine egg and one muscle, and two Roughleg fat samples and three muscles. In these cases, wet weights were estimated on the following assumptions: 74% water for egg and pectoral muscle and 10% for fat.

(qualitatively) by thin-layer chromatography. After sample extracts were injected into the gas chromatograph, the remaining extract was further cleaned up by Dindal's (1967) sulfonation procedure, which is a modification of that reported by Peterson and Robison (1964). We found that this modification could be further improved by separating the sulfonated lipids from the solvent by freezing the former rather than pouring off the solvent through a glass-wool filter.

We used Kovac's (1963) method for the spotting and development of thin-layer plates, modifying it for use with Eastman Chromagram® silica gel sheets as described by Dindal (1967).

Interference and pesticide recoveries

Impurities in solvents and other chemicals were checked regularly by running blanks through the analytical procedure. No interfering peaks were found which corresponded to any of the compounds sought.

Recently, polychlorinated biphenyls (PCB) have been found in birds of prey in Britain (Holmes, Simmons and Tatton, 1967), Sweden (Anonymous, 1966), the United States (Risebrough *et al.*, 1968a) and many other countries. More complete reviews of PCB toxicity, analytical interference, properties, and uses are now available (Risebrough, Reiche and Olcott, 1969; Reynolds, 1970; Peakall and Lincer,

1970). PCB are similar to organochlorine pesticides and metabolites in their chemical, physical and biological properties and have similar retention times on the gas chromatograph. Since a majority of the analytical work for this project was completed before the status of PCB was firmly established, intensive efforts to identify PCB were not made. Confirmation attempts on different columns failed to challenge original estimates of p,p′-DDE. However, peaks quantified as p,p′-TDE or p,p′-DDT reflected various residue levels depending on the column used. Therefore, the lowest residue level for a particular peak was calculated as if it was all TDE or DDT, thereby making the data available for crude estimates of PCB, as in the report by Anderson *et al.* (p. 96, 1969).

Periodically, samples were homogenized, subsampled, and fortified with pesticide standards for an estimation of per cent recovery. Recoveries were as follows with sample size indicated: DDE — 83% (3); TDE — 84% (3); DDT — 72% (4). No corrections were made for recovery.

Results

Predators

A total of 17 tissues from adult Peregrines and 14 from adult Roughlegs were analysed for total DDT which included p,p′-DDT, p,p′-TDE (DDD) and p,p′-DDE. However, owing to probable PCB interference with DDT and TDE, only the DDE values are reported in Table 1. Average residue levels in ppm (± SE, based on OD tissue weight) quantified *as* TDE and DDT, respectively, are as follows for the Peregrine: egg — 2.69 (± 1.36), 5.91 (± 3.08); brain — 1.74 (± 1.05), 12.8 (± 8.42); fat — 6.32 (± 1.67), 34.9 (± 15.2); pectoral muscle — 3.31 (± 1.34), 18.4 (± 9.37); liver — 1.29 (± 0.79), 3.48 (± 2.13); ovary — 6.75 (± 6.75), 10.1 (± 10.1). Similar values for the Roughleg are: egg — none detectable; brain — 0.04 (none), 0.47 (± 0.28); fat — 0.31 (± 0.09), 13.6 (± 9.40); pectoral muscle — 0.06 (± 0.02), 1.25 (± 0.95); liver — 0.10 (none), 0.52 (none); ovary — none detectable.

TABLE 2. — DDE residues in prey species of the Peregrine Falcon (ppm oven dry weight basis)

Species	Tissue	DDE
(a) Resident prey species		
Lagopus lagopus	pectoral muscle	0.21
Lagopus lagopus	fat	0.89
Lagopus lagopus	liver	ND*
Lagopus lagopus	pectoral muscle	0.36
Lagopus lagopus	pectoral muscle	ND
(b) Migrant prey species		
Anas carolinensis	pectoral muscle	0.15
Anas carolinensis	fat	4.55
Spatula clypeata	pectoral muscle	0.21
Spatula clypeata	fat	1.75

*None detectable.

Peregrine Falcon prey

Our material afforded the opportunity to analyze individual organs of a few resident and migrant prey animals. It also allowed a crude comparison with similar samples collected the previous year in interior Alaska (Cade *et al.*, 1968).

For resident prey, the Willow Ptarmigan (*Lagopus lagopus* (Linnaeus) was chosen. DDE (OD basis) for three pectoral muscle tissues, one liver and one fat sample is reported in Table 2a.

The migrants were represented by one Green-winged Teal (*Anas carolinensis* Gmelin) and one Shoveler (*Spatula clypeata* (Linnaeus). DDE (OD basis) for fat and pectoral muscle was determined for these (Table 2b).

Because the DDE values for residents and migrants were so similar to those given by Cade *et al.* (1968), we did not undertake a more extensive examination of Peregrine prey.

Rough-legged Hawk prey

Unlike the Peregrine's prey, the Roughleg's prey consists almost entirely of small ground mammals and is therefore resident. Total carcasses of six shrews were analyzed (Table 3). Since shrews are on a higher trophic level than

TABLE 3. — DDE residues in Rough-legged Hawk prey species (ppm oven dry weight basis)

Resident Species*	DDE
Sorex cinereus	0.21
Sorex cinereus	0.37
Sorex cinereus	ND
Sorex cinereus	0.37
S. arcticus	0.73
S. arcticus	0.22

*Whole, skinned carcass analyzed.

the mice, which form the bulk of the Roughleg's diet, the concentrations of DDE reported probably represent maximum possible dietary intake from small mammals. The two species analyzed were the Masked or Common Shrew (*Sorex cinereus* Kerr) and the Arctic Shrew (*S. arcticus* Kerr).

Discussion

Pesticides and Predators

Peregrine Falcon vs. Rough-legged Hawk by tissue

In order to compare the relationship between the DDE residues of Peregrine and Roughleg tissues more clearly, we calculated a ratio of residue levels for each tissue. Since we suspected that there might be a difference in ratios depending on how residue concentration is expressed, we calculated ratios on oven dry, wet weight, and extractable fat bases (Table 1). Of those tissues with three replicates, the highest Peregrine to Roughleg ratios (based on OD or WW basis) were found in muscle and brain tissues, followed by fat and egg. On a per cent EF basis, the Peregrine to Roughleg ratios were similar but the brain ratio was higher than that of the muscle (i.e. by approximately 40 per cent).

Egg

The average DDE residue of 131 ppm (OD) or 27.4 ppm (WW) found in Peregrine eggs was intermediate between that reported by Cade *et al.* (1968) and Enderson and Berger (1968). Cade and his coworkers found an average of 15.0 ppm (WW) total residue for two eggs (84% of which was DDE). Enderson and Berger reported averages of 17.8 ppm and 27.9 ppm DDE (WW) for five viable and two nonviable eggs, respectively. Peregrine eggs collected by Cade *et al.* (1968) were from the Yukon River in Alaska and were collected one year earlier (1966). Those of Enderson and Berger were also collected during the summer of 1966 but in northern Canada (Alberta to the Northwest Territories). Moore and Walker (1964) reported the average total chlorinated hydrocarbon residue for 12 Peregrine eggs collected in England as 14.4 ppm (WW). Of this total, p,p′-DDE made up 12.4 ppm.

The biological consequences of high residue levels in eggs are still uncertain. Early investigations indicated that dietary DDT had little effect on hatchability. However, subsequent studies showed that posthatching survival was drastically lowered as chicks absorbed high concentrations of a commercial wettable DDT powder (Jones and Summers, 1968) or dieldrin (Koeman, Oudejans and Huisman, 1967) from stored yolk. This differential residue accumulation appeared to be operating in the Peregrine eggs, with the extraembryonic tissue containing an average of approximately nine times more DDE than the embryonic tissue (OD weight basis — Table 4a). This ratio is reduced to approximately four when comparison is based on per cent EF (Table 4b), suggesting that at least some of the differential accumulation may result from unlike lipid contents of embryonic and extraembryonic tissues.

Probably the main significance of residue levels in eggs is that they reflect circulating levels in females at the time of ovulation and therefore serve as a convenient indication of parental contamination.

Brain

Of all the tissues compared, the Peregrine to Roughleg ratio of the brain residue level was the highest (disregarding the ovary because of small sample size) when concentration was based on EF (Table 1). The brain ratio was

TABLE 4. — Pesticide residue levels (ppm) in embryonic and extraembryonic tissue of two peregrine eggs

Egg	Tissue	DDE
(a) Oven dry weight basis		
a	embryonic	10.2
a	extra-embryonic	240
b	embryonic	27.6
b	extra-embryonic	94.5
(b) Grams extractable fat of oven dry weight basis		
a	embryonic	36.0
a	extra-embryonic	813
b	embryonic	298
b	extra-embryonic	597

very close to that of muscle on an OD basis, and 25 per cent less than the muscle ratio on a WW basis. This may be important since the brain residue content is commonly considered most indicative of long-term exposure and actual toxicity. The disproportionately high Peregrine brain residue may have some relevance to the apparent decrease in Peregrine populations and may reflect subtle specific differences in physiology and/or the more obvious and probable food chain differences.

The average DDE level for the Peregrine brain appeared to be approximately three times higher than those of the same tissues collected one year previously by Cade *et al.*, (1968) from the Yukon River. They reported the mean DDE level, for four Peregrine brains, to be 22.6 ppm (OD).

Fat

The average DDE residue level of 372 ppm (WW) for three Peregrine fat samples was somewhat higher than the average of 284 ppm reported for nine Northern Canadian breeding Peregrines but considerably higher than the 14.0 ppm reported for five southward bound migrant immatures (Enderson and Berger, 1968). Enderson and Berger stated, "the high levels in adults compared with immatures are accumulated after the young move southward for winter where the birds may be exposed to prey bearing residue levels higher than their northern counterparts . . ." The average DDE content (OD) reported here is also slightly higher than that reported for four adult fat samples (752 vs. 622 ppm), collected one year earlier by Cade *et al.* (1968).

Since triglyceride lipids and associated residues are mobilized during migration, reproduction, and other stresses, it may be irrelevant to compare fat residues from different sample populations, unless more history is known about the respective groups.

Muscle

The average DDE residue level of 114 ppm (OD) for Peregrine muscle was slightly higher than the 89 ppm reported by Cade *et al.* (1968) for four adult Peregrine breast muscles collected one year earlier from interior Alaska.

Liver

Based on OD, the average DDE found in three Peregrine livers was approximately 20 times that reported by Cade *et al.* (1968) for four similar tissues (i.e. 398 vs. 21 ppm). There is no obvious reason for this large difference, especially since the liver residues reported here showed the lowest coefficients of variation observed (34 per cent based on OD). The liver DDE residues reported by Cade *et al.* also appeared to exhibit small variation (range 7.33 ppm to 33.4 ppm, OD), and extractable fat contents for both sets of livers were similar (approximately 5 per cent).

Although only one Roughleg liver was available for analysis, its DDE residue content appeared commensurate with other Roughleg tissues, slightly exceeding fat. This level was generally higher than that reported for Roughleg livers of birds found dead in Great Britain, but many of the latter birds contained exceptionally high dieldrin residues too (Prestt, Jefferies and Macdonald, 1968).

Pesticides and Peregrine Prey Species

Resident ptarmigan contained from none detectable to 0.89 ppm DDE (OD) depending

on tissue sampled (Table 2). No peaks were observed with retention times similar to DDT or TDE. Cade *et al.* (1968) reported an average of 0.32 ppm (OD) DDE in resident boreal birds. Enderson and Berger (1968) pooled their prey species regardless of migration or food habits, and reported them to contain an average of 0.66 ppm (WW) DDE which would be approximately 2.5 ppm (OD) based on the assumption of 74% water (i.e. that of muscle).

Although Cade and his coworkers (1968) showed that waterfowl constitute approximately 50 per cent of the Alaskan Peregrine's diet by weight, they were only able to report on two samples of abdominal fat from scoters, which contained an average of 1.36 ppm DDE (OD). We analyzed two ducks which contained from 0.15 ppm to 4.55 ppm DDE (OD) depending on tissue sampled (Table 2). Migrant sandpipers analyzed by Cade *et al.* (1968) contained the highest residue of the prey species sampled ranging from 1.94 ppm to 10.5 ppm (average 6.02) DDE (OD).

Since migrant passerines, shorebirds, and waterfowl with high residue levels represent approximately 80 per cent of the Alaskan Peregrine's diet, this predator has limited opportunity to lessen its body burden of pesticides during its Arctic sojourn. This may be particularly critical during the early part of the breeding season when Peregrines are laying eggs and prey residue levels may still be relatively high (per unit weight of prey) after their migration. The fact that Peregrines feed at higher trophic levels than the Roughlegs throughout the year probably explains their higher residue levels.

Pesticides and Roughleg Prey Species

The shrews contained an average of 0.32 ppm DDE (OD) with a SE of 0.09. These levels appear very similar to the Peregrine's resident avian prey but appreciably lower than the migrating prey species. We still need to know what the levels are in the herbivorous rodents of northern Alaska.

Summary and Conclusions

During the summer of 1967, Peregrine Falcons, Rough-legged Hawks, their eggs, and prey species were collected along the Colville River in northern Alaska. On an OD weight basis, three Peregrine eggs averaged 131 ppm p,p'-DDE while three Roughleg eggs averaged 7.07 ppm. The lowest DDE residue levels were found in the brains. Three Peregrine brains averaged 58.2 ppm while the same number of Roughleg brains averaged 0.67 ppm. Of those tissues with a sample size of three, the tissue exhibiting the highest DDE level was the fat (i.e. 752 ppm in the Peregrine vs. 13.3 ppm in the Roughleg). All resident Peregrine prey contained less than 1.00 ppm DDE (OD) regardless of tissue sampled, while migratory prey ranged from 0.15 ppm (muscle) to 4.55 ppm (fat). Whole carcass analysis of shrews, one of the Roughleg's prey, averaged 0.32 ppm DDE (OD).

The presence of pesticide residues in resident Alaskan mammals and birds may at first seem difficult to explain, since no large-scale spraying has taken place north of the Brooks Range (pers. comm. — M. C. Brewer, Naval Arctic Research Laboratory, Barrow, Alaska; J. E. Dewey — Cooperative Extension, Cornell University), although there were some local applications around Umiat. The report by Risebrough *et al.* (1968b) indicating that atmospheric dust contained an average of 41 ppb chlorinated hydrocarbons by weight sheds some light on the phenomenon and may explain, in part, the presence of residues in resident Arctic species.

It is interesting to note that the Roughleg's prey contained approximately one-tenth to one-twentieth as much DDE as the Peregrine's migratory prey, and these and higher ratios were repeated in the Peregrine to Roughleg residue ratios (Table 1). Unfortunately, the influence of residues in prey taken during migration and on the wintering range of these raptors remains unknown. This aspect of the problem and the temporal residue changes in migrating prey, plus the pharmacodynamics associated with residue storage in and mobilization from fat, should be investigated.

If the Peregrines nesting on the Yukon River are "perilously balanced near the threshold level

of organochlorine residues that initiates dysgenic reproductive behavior and eventual population decline" (Cade *et al.*, 1968), then the Colville Peregrines, with their consistently higher residues, are in an even more serious situation. Studies carried out in 1970 indicate that only 25 per cent of the aeries on the Colville were occupied by pairs successful in fledging young (J. R. Haugh, unpublished report, Alaska Dept. of Fish and Game). In retrospect, the poor reproduction in 1969 (White and Cade, in press) may have heralded the beginning of a decline in this Arctic population.

Acknowledgments

The authors wish to thank Clayton White, John Haugh and Walter Spofford for their help in collecting samples, Daniel Dindal for suggestions on analytical procedures, and Gunter Zweig for the use of his excellent pesticide residue laboratory at the Syracuse University Research Corporation. Thanks go to Brian De Groff for computer assistance and to the chemical companies (Giegy, Shell, and Monsanto) for providing the necessary standards. The laboratory work was supported by grants from the U.S. Public Health Service (Nos. ES00261 and ES00306) to Dr. T. J. Cade. The specimens were collected during field work supported by a grant from the Arctic Institute of North America under contractual arrangements with the U.S. Office of Naval Research.

Literature Cited

American Ornithologists' Union. 1957. Check-list of North American Birds. 5th ed. Baltimore, Maryland, 691 p.

Ames, Peter L., and **Gerald S. Mersereau.** 1964. Some factors in the decline of the osprey in Connecticut. Auk 81(2): 173-185.

Anderson, D. W., J. J. Hickey, R. W. Risebrough, D. F. Hughes and **R. E. Christensen.** 1969. Significance of chlorinated hydrocarbon residues to breeding pelicans and cormorants. The Canadian Field-Naturalist 83(2): 91-112.

Anonymous. 1966. Report of a new chemical hazard. New Scientist 32: 612.

Cade, T. J. 1960. Ecology of the peregrine and gyrfalcon populations in Alaska. University of California Publications in Zoology 63: 151-290.

Cade, T. J., C. M. White, and **J. R. Haugh.** 1968. Peregrines and pesticides in Alaska. Condor 70(2): 170-178.

Craighead, J. J., and **F. C. Craighead, Jr.** 1956. Hawks, Owls and Wildlife. Stackpole Co., Harrisburg, Pa. and Wildlife Management Institute, Washington, D.C.

Dindal, D. L. 1967. Kinetics of Cl^{36} DDT in wild waterfowl. Unpublished Ph.D. Thesis. Ohio State University. 214 p.

Enderson, J. H. 1965. A breeding and migration survey of the peregrine falcon. Wilson Bulletin 77(4): 327-339.

Enderson, J. H., and **D. D. Berger.** 1968. Chlorinated hydrocarbon residues in peregrines and their prey species from northern Canada. Condor 70(2): 149-153.

Errington, P. L. 1933. Food habits of southern Wisconsin raptors. Condor 35: 19-29.

Fyfe, R. W., J. Campbell, B. Hayson and **K. Hodson.** 1969. Regional population declines and organochlorine insecticides in Canadian prairie falcons. The Canadian Field Naturalist 83(3): 191-200.

Hausman, L. A. 1928. The Hawks of New Jersey and their Relation to Agriculture. New Jersey Agric. Exp. Sta., New Brunswick, N.J., Bulletin No. 439. 48 p.

Heath, R. G., J. W. Spann and **J. F. Kreitzer.** 1969. Marked DDE impairment of mallard reproduction in controlled studies. Nature 224 (5214): 47-48.

Hickey, J. J., editor. 1969. Peregrine falcon populations: Their biology and decline. University of Wisconsin Press, Madison, Wisconsin. 596 p.

Holmes, D. C., J. H. Simmons, and **J. O'G. Tatton.** 1967. Chlorinated hydrocarbons in British wildlife. Nature 216: 227-229.

Jones, F. J. S., and **D. D. B. Summers.** 1968. Relation between DDT in diets of laying birds and viability of their eggs. Nature 21 (5134): 1162-1163.

Koeman, J. H., R. C. H. M. Oudejans, and **E. A. Huisman.** 1967. Danger of chlorinated hydrocarbon insecticides in bird's eggs. Nature 215 (5105): 1094-1096.

Kovacs, M. F. 1963. Thin-layer chromatography for chlorinated pesticide residue analysis. Journal of the Association of Official Analytical Chemists 46: 884-893.

Latham, R. M. 1950. The food of predaceous animals in northeastern United States, Pittman-Robertson Project 36-R Penn. Game Comm., Harrisburg, Penna. Report 1. 69 p.

Lockie, J. D., and **D. A. Ratcliffe.** 1964. Insecticides and Scottish golden eagles. British Birds 57(3): 89-102.

Luttringer, L. A., Jr. 1935. Hawks — what they eat. Nature Magazine 26(3): 173-175, 177.

McAtee, W. L. 1935. Food habits of common hawks. United States Department of Agriculture Circular No. 370. 36 p.

Moore, N. W., and C. H. Walker. 1964. Organic chlorine insecticide residues in wild birds. Nature 201(4924): 1072-1073.

Peakall, D. B. 1967. Pesticide-induced enzyme breakdown of steroids in birds. Nature 216: 505-506.

Peakall, D. B. and J. L. Lincer. 1970. Another long-life widespread chemical in the environment. BioScience, 20: 958-964.

Pearson, T. G. 1933. Ohio reports on food habits of hawks and owls. Bird Lore 35: 241-242.

Peterson, J. E., and W. H. Robison. 1964. Metabolic products of p,p' - DDT in the rat. Toxicology and Applied Pharmacology 6: 321-327.

Porter, R. D., and S. N. Wiemeyer. 1969. Dieldrin and DDT: Effects on sparrow hawk eggshell and reproduction. Science 165: 199-200.

Prestt, I., D. J. Jefferies, and J. W. Macdonald. 1968. Post-mortem examinations of four rough-legged buzzards. British Birds 61: 457-465.

Ratcliffe, D. A. 1963. The status of the peregrine in Great Britain. Bird Study 10: 56-90.

Reynolds, L. M. 1970. Pesticide residue analysis in the presence of polychlorobiphenyls (PCB's). Residue Reviews, in press.

Risebrough, R. W., P. Reiche (sic), **D. B. Peakall, S. G. Herman,** and **M. N. Kirven.** 1968a. Polychlorinated biphenyls in the global ecosystem. Nature 220: 1098-1102.

Risebrough, R. W., R. J. Huggett, J. J. J. Griffin, and **E. D. Goldberg.** 1968b. Pesticides: transatlantic movements in the northeast trades. Science 159: 1233-1236.

Risebrough, R. W., P. Reiche and **H. S. Olcott.** 1969. Current progress in the determination of the polychlorinated biphenyls. Bulletin of Environmental Contamination and Toxicology 4(4): 192-201.

Schneil, G. D. 1967. Population fluctuations, spatial distribution, and food habits of rough-legged hawks in Illinois. Kansas Ornithological Society Bulletin 18(4): 21-28.

Sladen, W. J. L., C. M. Menzie, and **W. L. Reichel.** 1966. DDT residues in adelie penguins and a crabeater seal from Antarctica: ecological implications. Nature 210 (5037): 670-673.

Snedecor, G. W. 1946. Statisical Methods (4th Ed.). The Iowa State College Press, Ames, Iowa. p. 149.

Stickel, L. F., W. H. Stickel, and **R. Christensen.** 1966a. Residues of DDT in brains and bodies of birds that died on dosage and in survivors. Science 151(3717): 1549-1551.

Stickel, L. F., N. J. Chura, P. A. Steward, C. M. Menzie, R. M. Prouty, and **W. L. Reichel.** 1966b. Bald Eagle Pesticide Relations. North American Wildlife and Natural Resources Conference Transactions 31: 190-200.

Stickel, L., and **W. Stickel.** 1969. Distribution of DDT residues in tissues of birds in relation to mortality, body condition, and time. Industrial Medicine and Surgery 38(3): 44-53.

White, C. M. 1968a. Diagnosis and relationships of the North American tundra-inhabiting peregrine falcons. The Auk 85(2): 179-191.

White, C. M. 1968b. Biosystematics of the North American peregrine falcons. Unpublished Ph.D. Thesis. University of Utah. 195 p.

White, C. M., and **T. J. Cade.** 1971. Cliff-nesting raptors and Ravens along the Colville River, Arctic Alaska. The Living Bird 10, in press.

Received April 21, 1970
Accepted July 23, 1970

Shell Thinning in Eggs of Ungava Peregrines

DANIEL D. BERGER
1328 North Jefferson, Apt. 311, Milwaukee, Wisconsin 53202.

DANIEL W. ANDERSON
Department of Wildlife Ecology, University of Wisconsin, Madison, Wisconsin 53706

JAMES D. WEAVER
Box 118, R.R. 2, Pecatonica, Illinois 61063

ROBERT W. RISEBROUGH
Institute of Marine Resources, Department of Nutritional Sciences, University of California, Berkeley, California 94720

Breeding populations of the Peregrine Falcon (*Falco peregrinus*) disappeared from many areas of North America during the period between 1950 and the early sixties (Hickey, 1969) but Peregrines have continued to persist in apparently normal numbers in northern Canada and in Alaska (Enderson and Berger, 1968; Enderson *et al.*, 1968; Cade *et al.*, 1968). In Britain, California, and the eastern United States Peregrine eggs collected during the period of the decline were subsequently found to be thin-shelled (Ratcliffe, 1967; Hickey and Anderson, 1968). In this paper we report on shell thinning observed in Peregrine eggs obtained from the Ungava region of northern Quebec and adjacent islands of the Northwest Territories in 1967 and 1970.

During July and August of 1967, under contract with the Canadian Wildlife Service, D. D. Berger and J. D. Weaver located fifteen eyries in Ungava. The objectives of this expedition were to obtain fat biopsy samples from breeding females and to collect a limited number of eggs for analysis of pollutants suspected to be the cause of the extinction process afflicting the Peregrine.

In 1970, also under contract with the Canadian Wildlife Service, D. D. Berger and R. W. Risebrough revisited some of these sites and located additional eyries while participating in a survey of breeding Peregrines in Arctic Canada (Cade and Fyfe, 1970). Data on reproductive success of five other Peregrine eyries in Ungava in 1970 and samples of addled and broken eggs have kindly been provided by Robert B. Berry and J. Peter Jenny, Jr. and their observations are incorporated into the present paper.

Fat was biopsied from nine females in 1967, of which four were from sites where eggs were also taken. Biopsy techniques have been described previously (Enderson and Berger, 1968). The fat samples and contents of the eggs collected were preserved in 10% formalin solution and were analysed by L. M. Reynolds. Analytical techniques for DDE were those described in Vermeer and Reynolds (1970).

Twelve eggs were obtained in 1967 and nine in 1970. Of these only one was fresh and viable when collected. Of the other 20, a clutch of four was abandoned when found with no adult in the vicinity, two eggs were broken with the contents removed, six were cracked and contained dead embryos, three were addled with no embryonic development, four were addled with dead mature embryos and one was addled with an early embryo. The egg sampling was therefore biased towards those eggs that were abandoned, addled, broken, or cracked.

Ten of the eggs collected in 1967 were analysed for the DDT compound p,p'-DDE' (DDE). The average concentrations were 12.7 ± 8.7 parts per million of the wet weight contents of the egg and 253 ± 160 ppm of the lipid material in the yolk and embryo (95% confidence limits of the standard error of the mean). The fat biopsy samples contained 310 ± 87 parts per million of DDE on a wet weight basis or 334 ± 95 ppm in the lipids. The egg residues are therefore comparable to those in two eggs collected in Alaska in 1966 that averaged 12.5 ppm on a wet weight basis and 285 ppm in the lipids (Cade *et al.*, 1968) and to those in five viable eggs from the Mackenzie River in 1966 that contained 17.8 ± 10.9 ppm wet weight (Enderson and Berger, 1968). The amounts of DDE in adult fat are comparable to the average concentration of 392 ppm in the lipid recorded in nine samples from the Mackenzie River in 1966 (Enderson and Berger, 1968), but are lower than an average concentration of 725 ppm in the lipid of four adult female Peregrines from Alaska (Cade *et al.*, 1968). Enderson *et al.* (1968) have reported that the total concentrations of organochlorine compounds of insecticide origin, of which DDE is the most abundant, in the fat of four adult female Peregrines on the Yukon River in 1967 were 130, 717, 754 and 2435 parts per million. The level of DDE contamination in the Ungava Peregrines is therefore equivalent to or somewhat lower than the levels existing in Peregrine populations elsewhere in the Arctic. 42 recent Peregrine eggs from those areas in Great Britain where the Peregrine has experienced reproductive failures correlated with shell thinning and egg breakage contained an average concentration of 13.7 ppm of DDE in the fresh weight contents (Ratcliffe, 1970). DDE constituted 90% of all organochlorine compounds of insecticide origin in the eggs. The DDE concentrations in the eggs of the Ungava Peregrines are therefore virtually the same as the concentrations recorded in the eggs of the British birds.

The temporal midpoint of our census in 1967 was July 16, approximately 5 days after the peak of the hatch. It might therefore be expected that the observed clutch and/or brood size would be slightly less than the mean clutch size of 3.0 reported by Hickey (1942) for Arctic North America, 2.9 for northern Alaska, and 3.1 for other Arctic localities (Cade, 1960). We found a mean of 2.67 eggs and/or young for the 15 eyries in 1967, including two sites occupied by subadult females. One of these had two eggs, and the other was tending an empty scrape. Four of the eyries contained 4 eggs and/or young, suggesting that checks made soon after laying is completed would reveal that clutches of 4 are more common than was previously supposed. The 1970 census was carried out in late July and early August, too late to obtain clutch size data.

Eggshell thickness was measured as described by Anderson and Hickey (1970). When more than one egg was taken from a clutch, the measurements within the clutch were averaged so that only one thickness value is presented per clutch. Fifty nine Peregrine eggs collected in the eastern Arctic between 1900 and 1940 and preserved in museums were measured to determine the shell thickness of eggs laid before the widespread introduction of the DDT compounds and other persistent pollutants into the environment and before changes in mean shell thickness of museum eggs can be detected. The mean thickness of the 59 museum eggs, which were treated individually rather than on a clutch basis was 0.369 ± 0.017 mm (95% confidence limits of the standard error of the mean). Thickness of the 21 recent eggs from twelve clutches was 0.291 ± 0.013 mm. The average reduction in shell thickness was therefore 21%. Because of the sample bias towards broken and cracked eggs, the mean thickness of eggs producing young might be somewhat greater. The shell thickness of the single viable egg and the mean thickness of the four abandoned eggs were 0.29 and 0.288 mm respectively. The two broken eggs averaged 0.275 mm (0.25 and 0.30 mm), the addled eggs with no embryonic development 0.310 mm (0.28, 0.32 and 0.33), the cracked eggs with dead embryos 0.290 mm (0.27 - 0.30 mm) and the single addled egg with an early embryo had a shell thicknes of 0.30. There is therefore a tendency for the addled eggs showing no embryonic development to be somewhat

thicker-shelled than the average, but all eggs showed approximately the same degree of thinning at a level that is sufficient to increase the probability of breakage. The eight eggs that were broken or cracked were collected at five eyries, four of which had one downy young and the fifth had two. The five addled eggs containing dead embryos were found at three sites. The presence of one or more downy young at each of these eyries reduces the probability that mortality resulted from adverse weather or from disturbance. It is not clear, however, whether the mortality can be attributed to the thinning of the eggshell.

Twenty three young and seventeen eggs were found in the fifteen eyries located in 1967. Of the eggs two were of undetermined status but were probably addled. Three were of a clutch from which the single fertile egg was collected, but the remaining two eggs disappeared during incubation. All other eggs were broken, cracked addled or abandoned. Eleven pairs were successful in hatching young and the average brood size of downy chicks per successful pair was therefore between 2.1 and 2.3. The average brood size per successful eyrie on the Colville River was 2.7 ($N = 21$) in 1952 and was 2.3 ($N = 19$) in 1959 (Cade, 1960).

In 1970 twelve occupied sites were visited between July 25 and August 15. Of these only seven were successful, and the mean brood size per successful pair was 1.7. The average number of young per occupied site dropped to 1.0 from 1.5 in 1967.

Our data are not sufficient to permit a conclusion about the overall current reproduction of the Ungava Peregrines since it would be necessary to visit each site several times spanning the breeding season from the return of the adults in the spring to the fledging of the young in order to determine the reproductive success per active eyrie. They indicate, nevertheless, that the population has reached a critical level of shell thinning resulting in the production of broken or cracked eggs and lower than normal numbers of young hatched. The reproductive rate, therefore, may not be sufficient to maintain the stability of the population.

The research was supported by the Canadian Wildlife Service.

Literature Cited

Anderson, D. W. and **Hickey, J. J.** 1970. Oological data on egg and breeding characteristics of Brown Pelicans. Wilson Bulletin 82: 14-28.

Cade, T. J. 1960. Ecology of the Peregrine and Gyrfalcon populations in Alaska. University of California Publications in Zoology 63: 151-290.

Cade, T. J., and **Fyfe, R.** 1970. The North American Peregrine Survey, 1970. Canadian Field-Naturalist 84: 231-245.

Cade, T. J., White, C. M., and **Haugh, J. R.** 1968. Peregrines and pesticides in Alaska. Condor 70: 170-178.

Enderson, J. H. and Berger, D. D. 1968. Chlorinated hydrocarbon residues in Peregrines and their prey species from northern Canada. Condor 70: 149-153.

Enderson, J. H., Roseneau, D. G., and **Swartz, L. G.** 1968. Nesting performance and pesticide residues in Alaskan and Yukon Peregrines in 1967. Auk 85: 683.

Hickey, J. J. 1942. Eastern population of the Duck Hawk. Auk 59: 176-203.

Hickey, J. J. [Editor] 1969. Peregrine Falcon Populations: Their Biology and Decline. University of Wisconsin Press, Madison. 596 pp.

Hickey, J. J. and **Anderson, D. W.** 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science 162: 271-273.

Ratcliffe, D. A. 1967. Decrease in eggshell weight in certain birds of prey. Nature 215: 208-210.

Ratcliffe, D. A. 1970. Changes attributable to pesticides in egg breakage frequency and eggshell thickness in some British birds. Journal of Applied Ecology 7: 67-115.

Vermeer, K. and **Reynolds, L. M.** 1970. Organochlorine residues in aquatic birds in the Canadian prairie provinces. Canadian Field-Naturalist 84: 117-130.

Received September 15, 1970
Accepted October 15, 1970

Mercury Contamination of Canadian Prairie Seed Eaters and their Avian Predators

N. FIMREITE
Department of Zoology, University of Western Ontario, London, Ontario

R. W. FYFE
Canadian Wildlife Service, Edmonton, Alberta

J. A. KEITH
Canadian Wildlife Service, Ottawa, Ontario.

Abstract. The investigation revealed that mercury contamination is rather widespread in prairie wildlife. Livers of seed-eaters shot on fields sown with treated grain contained significantly higher mercury levels than those shot on untreated fields, strongly suggesting mercury seed dressings as the major source of contamination. This suggestion is supported by mercury concentrations both in seed-eaters and in their avian predators being significantly higher in specimens from Alberta, where the use of mercury seed dressings is widespread, than in Saskatchewan where seed treatment is much less common.

There was considerable variation in mercury levels between and within species. Among seed-eating birds, the highest residue levels were found in pheasants. Lesser, but still considerable mercury concentrations were shown in partridges and small seed-eating passerine birds such as Horned Larks. Among the rodents, ground squirrels inhabiting treated fields were shown to have high mercury levels.

Eggs of the predominantly bird-eating falcons and accipiters were frequently found with elevated mercury levels while the levels in eggs of those eagles, buteos, and harriers which prey largely on rodents were low. This difference can be explained satisfactorily on the basis of their food habits since mercury levels were higher in principal bird prey species than in rodents.

Reproduction in falcons and accipiters may be adversely affected since their eggs frequently carried mercury levels comparable to those shown experimentally to reduce hatchability in pheasant eggs. This suggests that mercury is contributing to the recently documented organochlorine-related population declines.

Introduction

Organic mercury compounds are widely used as seed dressings for the control of seed- and soil-borne diseases in cereals and flax. Among the compounds are the alkyl mercury derivatives which have become predominant since the last world war because of their broad spectrum effect against various pathogens and comparatively low phytotoxicity. Unfortunately, from a wildlife viewpoint, this is also the most toxic and persistent form of mercury (Swensson, 1967). By entering the food chain through seed-eating birds that pick up uncovered treated grain, alkyl mercury may have most serious consequences for wildlife. This has been demonstrated in Sweden by Borg *et al.*, (1965, 1969) who reported hazardous levels of mercury both in seed-eating birds and their predators. As a result, alkyl mercury- containing seed dressings were banned in Sweden in 1966 and replaced by the less persistent alkoxy-alkyl mercury compounds. This change, together with a general reduction in the use of seed dressings, has apparently eliminated the use of mercury seed dressings as a hazard to wildlife in Sweden (Wanntorp, Borg, and Erne, 1967).

In Canada, however, alkyl mercury derivatives are the predominant fungicides used in seed dressings, and are used extensively (Fimreite, 1970a). The present study was undertaken to see whether Canadian seed-eating animals and their predators were contaminated by mercury from seed treatment of prairie grain.

Study Areas, Methods, and Materials

Following research into the current uses of mercury in Canada (Fimreite, 1970a), and based on the Swedish experience (Borg *et al.*, 1969), samples were collected of those forms of wildlife believed most likely to be contaminated.

The material for this study was collected during 1968 and 1969, and the major collection areas were southern Alberta and southern Saskatchewan (Figure 1). In southern Alberta, irrigation is widespread and mercury seed dressings are used extensively, while in contrast,

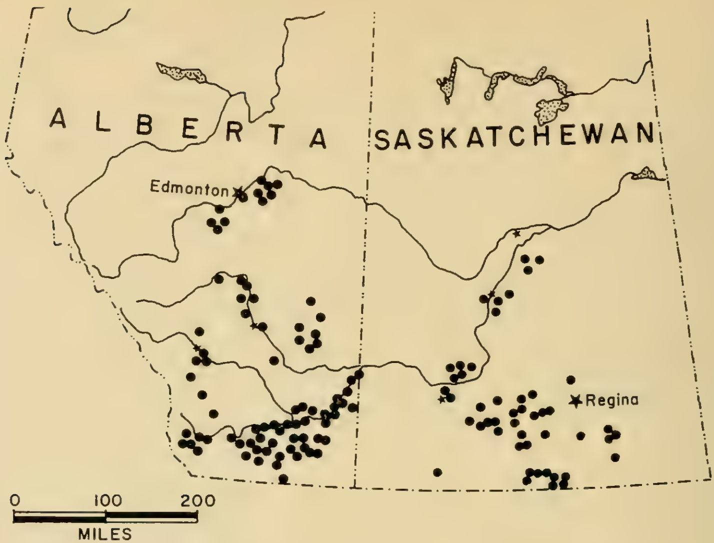


FIGURE 1. Outline map of Alberta and Saskatchewan showing sampling locations.

southern Saskatchewan is an entirely dry-farming district where seed treatment is less common. A comparison between these areas was judged valuable in order to test the significance of seed dressings as a source of mercury contamination of terrestrial wildlife.

The sample material included seed-eating birds, rodents, and predatory birds. Among seed-eating birds, the emphasis was laid on important upland game birds (pheasants and partridges) and certain small passerine birds known to be important as food for bird-eating birds of prey. In 1968, attention was paid to collecting seed-eating species specifically from areas where grain seed was known to have been treated as well as from areas where treated seed was not readily available.

In sharp contrast to the Swedish studies which included many samples found dead (Borg *et al.*, 1969), our samples of birds and mammals were shot in the wild except for one Short-eared Owl (*Asio flammeus*) and the single Prairie Falcon (*Falco mexicanus*), which we found dead. Raptor egg samples were collected at every opportunity and include fresh, partly incubated, and addled eggs.

Liver was chosen because it is known to concentrate and retain mercury entering the body (Westermark, 1967), is readily accessible through dissection, and is sufficiently large that enough tissue is available from even the smaller birds and mammals.

For birds of prey, eggs were sampled instead of livers because it was undesirable to collect a large number of adults. Egg samples were analyzed for both mercury and organochlorine residues. Prior to sending the egg contents for analysis, the outer dimensions of the intact eggs were measured and recorded. The contents were then removed and the shells were washed and allowed to dry at room temperature. Once dry, the shells were weighed to the nearest 0.01 gm. and Ratcliffe's (1967) shell-thickness index calculated (weight/length × width).

TABLE 1. — Mercury residues in livers of seed-eating animals (ppm).

GROUP/SPECIES	Alberta			Saskatchewan		
	$\bar{x} \pm$ SE	(n)	Range	$\bar{x} \pm$ SE	(n)	Range
UPLAND GAME BIRDS						
RING-NECKED PHEASANT (*Phasianus colchicus*)	2.835 ±0.583	(10)	0.484–5.92			
GRAY PARTRIDGE (*Perdix perdix*)	1.115 ±0.406	(7)	0.447–2.71	0.549 ±0.506	(9)	0.019–4.50
SHARP-TAILED GROUSE (*Pedioecetes phasianellus*)				0.202 ±0.151	(7)	0.021–1.11
PIGEONS & DOVES						
ROCK DOVE (*Columba livia*)	0.705 ±0.364	(3)	0.015–3.16	0.304	(1)	
MOURNING DOVE (*Zenaidura macroura*)	0.239 ±0.053	(8)	0.139–0.319	0.415	(1)	
WATERFOWL						
MALLARD (*Anas platyrhynchos*)	0.316 ±0.053	(2)	0.215–0.417			
SONGBIRDS						
HORNED LARK (*Eremophila alpestris*)	1.573 ±1.004	(10)	0.020–10.2	0.454 ±0.142	(8)	0.019–0.943
REDWINGED BLACKBIRD (*Agelaius phoeniceus*)	0.884	(1)				
BREWER'S BLACKBIRD (*Euphagus cyanocephalus*)	0.489 ±0.115	(4)	0.304–0.817			
WESTERN MEADOWLARK (*Sturnella neglecta*)	0.284 ±0.181	(3)	0.077–0.64			
BROWN-HEADED COWBIRD (*Molothrus ater*)	0.274	(1)				
VESPER SPARROW (*Pooecetes gramineus*)	0.162	(2)	0.113–0.210			
CHESTNUT-COLLARED LONGSPUR (*Calcarius ornatus*)	0.098	(2)	0.066–0.129			
RODENTS						
RICHARDSON'S GROUND SQUIRREL (*Spermophilus richardsonii*)	1.051 ±0.571	(7)	0.018–3.47	0.102 ±0.020	(2)	0.082–0.122
WHITE-FOOTED MICE (*Peromyscus* spp.)				0.231 ±0.203	(4)	0.017–0.838

All samples were freeze-dried by L. M. Reynolds, Ontario Research Foundation, Sheridan Park, Ontario, and analyzed for mercury using the neutron activation technique by L. E. Kovar, Gulf General Atomic Incorporated, San Diego, California, with the following analytical procedure:

> "Weighed portions of each sample, and a comparator mercury standard, were sealed in clean quartz ampoules, numbered, weighed, and then irradiated for 67 hours in a nuclear reactor at a thermal-neutron flux of 2×10^{12} n/cm^2-sec. After allowing the samples to decay for two days, in order to reduce the amount of ^{24}Na activity present, the samples were subjected to radiochemical separation by the procedure of Sjöstrand (Anal. Chem. *36* (1964) 814). In this procedure, the irradiated sample is dissolved, in a nitric and sulfuric acid mixture (containing 20 mg of non-radioactive mercury carrier) under reflux conditions. After the sample is dissolved, mercury is distilled and finally electroplated onto a preweighed gold foil. The gold foil is weighed, to obtain the net weight of recovered mercury carrier and the sample is counted with a 2-inch by 2-inch well-type NaI (T1) detector, coupled to a multichannel pulse-height analyzer Comparison of the integrated x-ray/γ-ray photopeaks at 68-77 keV from 65-hour Hg^{197} in the samples with that of the standard, followed by correction for the carrier recovery, provides for the quantitation of Hg."

TABLE 2. — Mercury residues in livers of predators of seed-eating animals (ppm).

GROUP/SPECIES	Alberta			Saskatchewan		
	$\bar{x} \pm$ SE	(n)	Range	$\bar{x} \pm$ SE	(n)	Range
OWLS						
SHORT-EARED OWL (*Asio flammeus*)	6.837 ±3.289	(3)	0.420 – 11.30			
BURROWING OWL (*Speotylo cunicularia*)	3.735	(2)	1.23 – 6.24	0.729	(1)	
FALCONS						
PRAIRIE FALCON (*Falco mexicanus*)	1.260	(1)				
SPARROW HAWK (*Falco sparverius*)	0.755	(1)				
BUTEOS						
SWAINSON'S HAWK (*Buteo swainsoni*)	0.762 ±0.239	(5)	0.230– 1.48	0.451 ±0.081	(8)	0.219–0.949
RED-TAILED HAWK (*Buteo jamaicensis*)	0.483	(1)				
HARRIERS						
MARSH HAWK (*Circus cyaneus*)				0.069 ±0.030	(3)	0.028–0.127

TABLE 3. — Mercury residues in eggs of predators of seed-eating animals (ppm).

GROUP/SPECIES	Alberta			Saskatchewan		
	$\bar{x} \pm$ SE	(n)	Range	$\bar{x} \pm$ SE	(n)	Range
OWLS						
GREAT HORNED OWL (*Bubo virginianus*)	1.940	(1)		0.076±0.017	(6)	0.014−0.121
BURROWING OWL (*Speotyto cunicularia*)				0.112	(1)	
FALCONS						
PIGEON HAWK (*Falco columbarius*)	0.283±0.045	(10)	0.153−0.543			
PRAIRIE FALCON (*Falco mexicanus*)	0.240±0.038	(46)	0.019−1.71	0.169±0.036	(12)	0.033−0.427
ACCIPITERS						
SHARP-SHINNED HAWK (*Accipiter striatus*)				0.119	(1)	
COOPER'S HAWK (*Accipiter cooperii*)				0.085	(2)	0.044−0.126
BUTEOS						
RED-TAILED HAWK (*Buteo jamaicensis*)	0.342±0.165	(10)	0.035−1.62	0.052±0.013	(4)	0.023−0.080
SWAINSON'S HAWK (*Buteo swainsoni*)	0.120±0.054	(7)	0.030−0.417	0.283	(1)	
FERRUGINOUS HAWK (*Buteo regalis*)	0.066±0.031	(7)	0.011−0.249	0.034±0.009	(4)	0.023−0.061
EAGLES						
GOLDEN EAGLE (*Aquila chrysaetos*)	0.100±0.059	(3)	0.024−0.218	0.025	(2)	0.017−0.032
HARRIERS						
MARSH HAWK (*Circus cyaneus*)	0.031±0.008	(5)	0.018−0.060	0.014	(1)	

Mercury residue values are given in parts per million (ppm) on a wet (fresh) weight basis.

Organochlorine levels and details of shell thickness measurements in the bird of prey eggs will be reported in detail by one of us (R.W.F.) in a separate paper.

Results

All samples analyzed contained mercury residues, however, considerable variation was found between species and within samples of the same species. The mercury levels for each species sampled are summarized by province in Tables 1, 2, and 3.

Among seed-eating game birds (Table 1), the most elevated mean residue levels were found in Ring-necked Pheasant (*Phasianus colchicus*) and Gray Partridge (*Perdix perdix*) the two species of resident upland game birds most frequently associated with farmyards, roadsides and cultivated fields, while in Sharp-tailed Grouse (*Pedioecetes phasianellus*), which prefers wild grasslands, only moderate or low levels occurred. Horned Lark (*Eremophila alpestris*), an early spring migrant that also frequents roadsides and cultivated fields feeding on weed seeds and grain, carried mercury levels similar to those found in pheasants and partridges. Slightly lower levels were found in later migrants including Redwinged Blackbird (*Agelaius phoeniceus*), Brewer's Blackbird (*Euphagus cyanocephalus*) and Western Meadowlark (*Sturnella neglecta*), all collected near farm buildings or in cultivated fields. The lowest residues were in Vesper Sparrow (*Pooecetes gramineus*) and Chestnut-collared Longspur (*Calcarius ornatus*) which were collected in areas of open grassland.

TABLE 4. — Comparison of mercury levels (ppm) in livers of seed-eating birds and rodents from treated and untreated areas.

	Hg Residues from Treated Areas		Hg Residues from Untreated Areas		Significance of the difference between the groups
	(n)	$\bar{x} \pm$ SE	(n)	$\bar{x} \pm$ SE	
Rodents	(6)	1.248±0.683	(5)	0.180±0.149	
Songbirds	(10)	1.632±0.997	(3)	0.034±0.012	
Upland Game Birds	(19)	1.880±0.444	(12)	0.348±0.223	
All Seed Eaters	(35)	1.701±0.379	(20)	0.259±0.139	$P < 0.01$

TABLE 5. — Comparison of mercury levels (ppm) in eggs of predators and in livers of seed-eating prey from Alberta and Saskatchewan

	Alberta		Saskatchewan		Significance of the difference between the groups
	(n)	$\bar{x} \pm$ SE	(n)	$\bar{x} \pm$ SE	
Predatory Birds (egg)	(89)	0.236±0.035	(34)	0.103±0.017	$P < 0.05$
Seed-eating Prey (liver)	(61)	1.160±0.231	(32)	0.370±0.148	$P < 0.05$

Only a limited number of adult predators was examined for mercury residues in liver. Among these were three Short-eared Owls (*Asio flammeus*) of which two showed high mercury levels, the highest (11.3 ppm) being recorded in a specimen found dead (Table 2).

Elevated mercury levels were found in the egg contents of the majority of the predatory birds sampled (Table 3). However, as with the seed eaters, and with the exception of those forms most specific in their food preferences, a wide variability in the mercury content was evident in the eggs of each species. The range of residue levels was most pronounced in the eggs of the Great Horned Owl (*Bubo virginianus*) and Red-tailed Hawk (*Buteo jamaicensis*) two species which frequently utilize a wide variety of both birds and mammals as prey (Luttich *et al.,* 1970; Rusch *et al.,* 1970).

In 1968, 55 samples of seed-eating birds and rodents were specifically collected from treated and untreated areas in both provinces to demonstrate any possible relationship between tissue mercury levels and the use of mercurial fungicides for seed treatment. A comparison of the mean residue levels (Table 4) shows considerably higher mercury content in each group of samples from treated areas than in the groups from untreated areas. The difference between the total sample of seed-eating animals from treated and untreated areas is significant ($P < 0.01$).

A similar comparison of residue levels in the livers of seed-eating species and in the eggs of raptors from Alberta, where mercurial fungicides are used extensively, with those from Saskatchewan, where mercurial seed treatment is much less extensive, is shown in Table 5. The difference in mercury residue levels in the samples from the two areas is also significant ($P < 0.05$).

Consistently high levels were found in the egg contents of the Pigeon Hawk (*Falco columbarius richardsonii*), which feeds primarily on small birds, and the Prairie Falcon (*Falco mexicanus*) which primarily, though not exclusively, feeds on passerine birds. Similarily uniform and equally elevated mercury residues (0.315 - 0.568 ppm) were present in four Peregrine Falcon (*Falco peregrinus*) eggs from the Northwest Territories. The Peregrine Falcon is also known to prey heavily on small birds throughout the year.

In contrast to the high residue levels found in the eggs of predominately bird-eating falcons, there are significantly ($P < 0.05$) lower mercury levels in the eggs of the most specific mammal eaters (Table 6). Consistently low levels are most evident in the eggs of the Ferruginous Hawk (*Buteo regalis*), which in western Canada feeds almost exclusively on Richardson's ground squirrel (*Spermophilus richardsonii*); the Golden Eagle (*Aquila chrysaetos*), which in this study area feeds primarily on the white-tailed jackrabbit (*Lepus townsendii*); and the Marsh Hawk (*Circus cyaneus*), which preys heavily on small mammals.

Discussion

Seed eaters

Elevated liver mercury levels were found in the majority of the seed-eating birds examined. However, there was a significant difference between birds collected from treated areas and

TABLE 6. — Mercury levels (ppm) in eggs of buteos, harriers, and eagles, compared with falcons and accipiters.

	Buteos, Harriers and Eagles		Falcons and Accipiters		Significance of the difference between the groups
	(n)	$\bar{x} \pm$ SE	(n)	$\bar{x} \pm$ SE	
Mercury Residues in Eggs	(44)	0.133 ± 0.042	(71)	0.288 ± 0.027	$P < 0.05$

those from untreated areas, the former having the highest mercury levels. This along with the fact that the mercury levels in the Alberta specimens significantly exceeded those from Saskatchewan where seed treatment is far less common, indicates that mercury seed dressings are the primary source of contamination.

Within seed-eating birds, consistently high levels were found in the two upland game birds most associated with grain farming, pheasant and partridge. This is not surprising as grain figures prominently in the diet of these birds (Trippensee, 1948). In contrast, the grouse, which is much more restricted to native grassland carried only low or moderate mercury levels. Among songbirds there seems to be more variation, the Horned Lark being the best represented and showing a range of 0.02 ppm to 10 ppm. The variation between the mercury levels from treated versus non-treated fields was also more pronounced for small seed-eating birds and rodents than for game birds. This is, in part, explained by the fact that large birds such as pheasants and partridges have a larger feeding territory than do smaller birds and rodents (Schoener, 1968) and thus the chance for having their feeding territory restricted to a specific field would be much less.

Our findings can be best compared with those of Borg *et al.* (1969) who found that of 298 seed-eating birds shot for investigation in Sweden before alkyl mercury compounds were banned there, 41% carried liver mercury levels above 2 ppm. The percentages of seed-eating birds in our investigation carrying similarly high levels were 23% and 4% for Alberta and Saskatchewan respectively.

In Sweden, Borg *et al.* (1969) found that a large number of seed-eating and raptorial birds found dead had been poisoned by mercury. The same study showed experimental lethal effects in four pheasants with liver levels of 67-171 ppm, at least six times higher than the highest levels we found. Taken together, these fragmentary data suggest that, in contrast to Sweden, direct mortality of seed-eating birds may not have been associated with mercury seed treatment on the Canadian prairies.

In experiments involving 192 penned pheasants, Fimreite (1970b) found that hens with mercury liver levels of 3-13 ppm laid eggs with concentrations of 0.5 - 1.5 ppm which had significantly lowered hatchability than the controls. Borg *et al.* (1969) noted the same effect. Five of the 10 wild pheasants taken in Alberta had liver levels above 3 ppm, so that some reduced hatchability of Alberta pheasants due to mercury is a distinct possibility.

For popular game birds we must also take into account the possibility of human hazard. Although the levels in muscle would be lower by a factor of 2-4 than those found in liver (Westermark, 1967), it is obvious that the levels in the Alberta pheasant and partridge muscle samples would be expected to exceed that of FAO/WHO Codex Alimentarius Commission proposed acceptable concentration in foodstuff of 0.05 ppm.

It is probable that the most serious wildlife problem will arise at higher trophic levels. As food for raptors, the contaminated seed-eating birds can cause ecological problems since alkyl mercury is persistent in the animal body (Swensson, 1967) and concentrates in food chains. This suggestion has been supported experimentally by a demonstration of increased mortality or severe damage of the nervous system in Red-tailed Hawks fed a diet of chicks

containing 7-10 ppm of mercury in the liver (Fimreite and Karstad, 1970). These concentrations are comparable to the highest levels found in seed-eating birds in our samples.

Predators

It should be noted that since only liver tissue was analyzed from the seed-eating bird samples no direct comparison of levels can be made with the residues in the egg contents of the predatory birds. However, experimental data on residues in livers of hen pheasants and their eggs (Fimreite, 1970b) and the residue levels in the liver of one adult Prairie Falcon and her egg suggest mercury residues in the livers of female birds to be 5-9 times those in the eggs.

Because of the large hunting territories of the birds of prey we were not able to determine with certainty whether the prey of a specific pair was restricted to either treated or untreated areas. However, since raptor egg samples collected in southern Alberta (where mercurial seed-dressings are used extensively) are widely separated geographically from those collected in southern Saskatchewan (where these seed-dressings are used infrequently or in small amounts) our comparison of residues found in samples from these areas is essentially a comparison of samples from a treated and an untreated area.

The differences by area shown in these comparisons are significant and point to seed dressings as the primary source of mercury contamination in these species. These results also strongly suggest seed-eating prey as the major source of mercury contamination of these predatory birds.

The wide variation in the mercury content of the eggs of those species frequently utilizing both birds and mammals for food suggests a corespondingly wide variation in the levels of contamination of their prey. Similarly it is apparent that the uniformly low residue levels in the eggs of those species feeding mainly on mammals show a wide separation from the relatively high yet equally uniform levels in the eggs of species preying primarily on birds. A comparison of the mercury residues found in the predominately bird-eating falcons and accipiters with the residues in the predominately mammal-eating buteos, harriers and eagles shows the difference between the two groups to be significant, and these findings closely parallel those reported by Borg *et al.* (1969). These data clearly point to the seed-eating birds as the major carrier of mercury contamination and at the same time indicate mammals are much less of a mercury hazard to predatory birds.

Unfortunately our sample of small mammals is not representative and is too small to provide any indication of general levels. However, the comprehensive study of Lihnell and Stenmark (1967) shows Swedish small mammals carrying much lower levels of mercury than the seed-eating birds. On the other hand, our mammal sample does indicate that we cannot entirely ignore contamination in these prey since the ground squirrels collected in treated areas did show elevated mercury levels.

The potential ecological mercury hazard created by the presence of high residues in seed-eating birds is demonstrated by the occurrence of high levels in the Horned Lark and in the eggs of the Pigeon Hawk and the Prairie Falcon which both prey heavily on the Horned Lark (Enderson, 1964; Fox, 1964). Similarly, we found pheasant remains at the nest site of the pair of Prairie Falcons whose eggs showed the highest mercury content for this species. In 1968 only one of five eggs in this nest hatched, the remaining four eggs contained mercury levels ranging from 0.9 - 1.7 ppm. In 1969 only the female of the pair was observed at the site, and no nesting occurred.

As already mentioned, experiments with pheasants indicate that alkyl mercury may have strong adverse effects on reproduction (Fimreite, 1970b). Since the mercury concentrations in the eggs of falcons frequently are in the same range, reproductive effects must be expected in wild falcons. This coincides also with the recently documented declines in populations of Prairie Falcon (Fyfe *et al.*, 1969) and Pigeon Hawk (Fyfe, *unpublished*) in western Canada and is reinforced by the fact that several of the eggs collected for this study were addled and contained high mercury concentrations. Reproductive failures in the White-tailed Eagle in Finland and Sweden have been caused by mer-

cury contamination according to Henriksson, Karppanen, and Helminen (1966) and Borg *et al.* (1969). The source in this case, however, was mercury-containing slimicides used in the pulp industry.

A comparison between eggshell thickness (using the Ratcliffe index) and mercury content in 59 Prairie Falcon eggs failed to show the inverse correlation that we found between DDE content and shell thickness in these same eggs. (Fyfe, *unpublished*).

Possible synergism between mercury and DDE and between mercury and heptachlor should be taken into account as considerable DDE and heptachlor concentrations were found in many of the eggs (Fyfe, *unpublished*) and were positively correlated with those of mercury. This would be most serious for the bird-eating falcons which are exposed to both organochlorine pesticides and mercury contamination through seed-eating birds.

Literature Cited

Borg, K., H. Wanntorp, K. Erne, and **E. Hanko.** 1965. Kvicksilverförgiftningar bland vilt i Sverige. Rapport från Statens Veterinarmedicinska Anstalt, Stockholm [Report from the State Veterinary Medical Institute, Stockholm], 50 pp. + tables.

Borg, K., H. Wanntorp, K. Erne, and **E. Hanko.** 1969. Alkyl mercury poisoning in terrestrial Swedish wildlife. Viltrevy 6: 301-379.

Enderson, J. H. 1964. A study of the Prairie Falcon in the central Rocky Mountain region. Auk 81: 332-352.

Fimreite, N. 1970a. Mercury uses in Canada and their possible hazards as sources of mercury contamination. Environmental Pollution 1. In Press.

Fimreite, N. 1970b. Effects of dietary methyl mercury on Ring-necked Pheasants, with special reference to reproduction. Canadian Wildlife Service Occasional Papers. In Press.

Fimreite, N., and **L. Karstad.** 1970. Effects of dietary methyl mercury on Red-tailed Hawks. Journal of Wildlife Management. In Press.

Fox, G. A. 1964. Notes on a western race of the Pigeon Hawk. Blue Jay 22: 140-147.

Fyfe, R. W., J. Campbell, B. Hayson, and **K. Hodson.** 1969. Regional population declines and organochlorine insecticides in Canadian Prairie Falcons. Canadian Field-Naturalist 83: 191-200.

Henriksson, K., E. Karppanen, and **M. Helminen.** 1966. High residue of mercury in Finnish White-tailed Eagles. Ornis Fennica 43: 38-45.

Lihnell, D., and **A. Stenmark.** 1967. Bidrag til kännedomen om förekomsten av kvicksilver i smågnagare. Statens växtskyddsanstal Meddelanden [The Swedish National Institute for Plant Protection] Contribution 13(110): 361-379. (English summary).

Luttich, S., D. H. Rusch, E. C. Meslow, and **L. B. Keith.** 1970. Ecology of Red-tailed Hawk predation in Alberta. Ecology 51: 190-203.

Ratcliffe, D. A. 1967. Decrease in egg shell weight in certain birds of prey. Nature 215: 208-210.

Rusch, D. H., E. C. Meslow, P. D. Doerr, and **L. B. Keith.** 1970. Response of Great Horned Owl populations to changing prey densities. Symposium on Predator Ecology and Management. North Central Section of the Wildlife Society. In Press.

Schoener, T. W. 1968. Sizes of feeding territories among birds. Ecology 49: 123-141.

Swensson, A. 1967. The toxicology of different organo-mercurials used as fungicides. Oikos Suppl. 9: 27-29.

Trippensee, R. E. 1948. Wildlife Management 1. McGraw-Hill, New York. 439 pp.

Wanntorp, H., K. Borg and **K. Erne.** 1967. Mercury residues in Wood Pigeons (*Columba p. palumbus* L.) in 1964 and 1966. Nordisk Veterinaer Medisin 19: 474-477.

Westermark, T. 1967. Mercury content in feathers of Swedish birds from the past 100 years. Oikos Suppl. 9: 39-40.

Received September 1, 1970
Accepted September 21, 1970

The Birds of the Belcher Islands, N.W.T., Canada

Milton M. R. Freeman[1]
Marine Sciences Centre,
McGill University

Abstract. The Belcher Islands in S.E. Hudson Bay possess a rich avifauna reflecting both proximity to the Hudsonian life zone and a low-latitude extension of the arctic (tundra) biome. Utilizing 3 seasons observations by the author, local informants' opinions and literature sources, the status of each of the 56 species reported as occurring on the Belcher Islands is reviewed. Nineteen species are known to breed on the Islands, six species occur seasonally during migration flights, and a further thirteen can be classed as rare or accidental visitors. One species reported in the literature (Ivory gull) is considered an erroneous report. The numerical and breeding status of some species (e.g. red-throated loon, red-breasted merganser, raven etc.) likely fluctuate from year to year, whereas certain other species (e.g. arctic tern, surf-scoter, white-rumped sandpiper, common redpoll) appear to have suffered a decline in status over a period of years.

The Belcher Islands represent a landmass approximately 2000 square miles in area, situated less than 100 miles from the southeast coast of Hudson Bay. The Islands present a typically arctic environment, being greatly influenced by the surrounding cold waters and frequent strong winds of Hudson Bay.

Large areas of the Belcher Island archipelago are covered by tundra vegetation, or by lichen-encrusted glaciated outcrops; nowhere are trees found. This treeless condition contrasts with the adjacent Ungava mainland, which at this latitude falls within the Hudsonian life zone. The Islands are generally low lying; cliff-development and the occasional rounded hills are usually not more than two hundred feet in height. Rivers are very few in number, and short in length; standing water is extremely abundant, ranging in size from temporary tundra pools to the large Kasegalik Lake, over forty miles in length.

The birds of Ungava are now fairly well reported in the literature, at least with regard to their distribution (e.g. Harper 1959; Todd 1963). However, the avifauna of the Islands in the east Hudson Bay has received only scant attention until now (Sutton 1932; Manning 1946, 1949; Todd 1963), and the following is offered as a further contribution to the existing records of birds breeding and visiting this extensive southern pocket of the arctic biome.

The first reliable reference to the Belcher Island avifauna, appears to be in the popular account of the 1938 Carnegie Museum expedition to Ungava and the Belcher Islands

(Twomey and Herrick 1942). The use of trinomials in this present paper is based on the known distributions of the nominate races, rather than examination of Belcher Island specimens.

The writer visited the Islands from May 10 until September 2, 1959, and the following year from April 19 until September 29. The area

[1]Present Address: Memorial University of Newfoundland, St. John's, Newfoundland.

was again visited from February 28 until April 16, 1961. Most of the time was spent in the region between the southwest corner of Kasegalik Lake and the Kasegalik River mouth. Visits were made to Tukarak Island by way of Omarolluk Sound and French Island on a number of occasions at all seasons. Eskimo Harbour, Snape Island, Spence Harbour and some other locations were visited briefly. The western and southwest parts of the archipelago were only visited in winter, and the North Belcher Islands were not visited at all. Owing to the absence of records from other parts of the Belcher Island group, it is not possible to assess how representative of the total avifauna, these somewhat localized observations are.

The Belcher Island names for most common species are included in the text. The system of spelling the names follows that employed by Thibert (1954).

COMMON LOON (TUDLIK)

Gavia immer (Brunnich)

The first loons to arrive in 1959 were of this species. A pair was seen swimming at the mouth of Kasegalik River on May 31; it was collected by an Eskimo hunter, and by the following day another pair had occupied the same stretch of open water.

In 1960 the first loon of the year was heard on the evening of May 24. A pair was shot in the Kasegalik River mouth area by an Eskimo on May 31 and the crop of one was seen to contain the remains of an arctic char. A female taken in the same region on June 3 had been feeding on sticklebacks, (*Gasterosteus*).

Two loons were swimming on the tidal part of the Kasegalik River a few hundred yards from the mouth. By June 9 they were feeding together but apart from a few weak attempts at courtship display, breeding activities had not commenced by June 26.

In the Kasegalik Lake outflow area, nesting activities were observed on June 18. The first eggs were seen in an Eskimo tent a mile east of the Kasegalik River mouth on July 10.

Common Loon were observed in the central regions of Kasegalik Lake during August.

ARCTIC LOON (KUDLULIK)

Gavia arctica pacifica (Lawrence)

This bird was first heard on June 11, 1959. The first sighting was on June 14 when a pair was seen on the open water by the Kasegalik River mouth.

None were seen in 1960.

Twomey reports this species breeding on Tukarak Island and in Omarolluk Sound (Todd 1963).

RED-THROATED LOON (KRUKSAUT)

Gavia stellata (Pontoppidan)

A pair was observed on the sea one mile east of Kasegalik River on June 23, 1959. A pair was seen on June 30 in a bay of open water at the southwest corner of the still ice-covered Kasegalik Lake.

On July 3 a pair, possibly nesting, was disturbed on a small pond on the cliff-top at the south end of the East Arm of Kasegalik Lake.

No birds of this species were observed in 1960.

According to Twomey, this is the commonest of the Loons on the Belcher Islands; he also reports this bird nesting on the archipelago (Todd 1963).

WHISTLING SWAN (KRUTJUK)

Olor columbianus (Ord).

A pair was seen flying north over the interior of Tukarak Island on May 17, 1959, and another pair also flying north reported by an Eskimo at Freakly Point on May 24.

The only record in 1960 was a pair feeding at the western entrance of Eskimo Harbour. The date was uncertain, but the skull was brought into our camp near the Kasegalik River on June 16, one of the pair having been shot some days before.

The species was reported by some Eskimos to nest on the North Belcher Islands, and on islands in the north of Churchill Sound. However, this was refuted by another informant, who had recently walked over the land in question; this informant had seen swan nests on Mansel Island in earlier years (cf. Manning 1949). However, the former presence of Swans on the North Belcher Islands is suggested by

the local names for the two largest islands in the group, *krutjuktogassak* and *krutjuktog*: it appears they were already becoming scarce however, thirty years ago (Burwash 1927) although they were still nesting locally in 1938 (Todd 1963).

CANADA GOOSE (NUDLIK)
Branta canadensis interior Todd.

This is the most widespread wildfowl on the Belcher Islands, and plays an important role in the subsistance economy of the Eskimos from early May to September.

The first birds were seen on April 30, 1960 at the outflow of the Kasegalik Lake, where a single bird was on the open water below the falls and three others were flying. During the first week of May many were seen each day flying in small groups of around six birds, in the neighbourhood of Kasegalik River. However, on May 7 the trader reported that no geese had been seen in the northeast of the Islands. One was seen that day about twenty miles to the southwest of the Post, in Omarolluk Sound.

In 1959, numbers were seen on the southeast coast of Tukarak Island on May 17 and on May 9 we had seen a small group flying over the sea ice about 40 miles east of Tukarak Island. On May 13 Eskimos arriving at the Post from Churchill Sound had a Canada Goose with them.

By the end of the second week of May, 1960, pairs were being flushed from likely nesting areas, and the first egg was found on May 20; another nest, with two eggs was found on the following day. These were from the central part of Kasegalik Lake, about twenty miles northeast of the outflow. By May 30 the Eskimos were reporting large numbers of eggs each day. The first eggs in 1959 were found on May 22 (3 eggs) and two more nests with three and one egg, on May 23.

Pipped eggs were seen in a nest in the Kasegalik River region on June 25, 1960, and a gosling was brought into camp by an Eskimo on June 26, 1959. Goslings were numerous by June 30, 1959, the adults being flightless by this date.

The largest number of eggs seen was six (June 9, 1959) but five eggs were seen on three occasions (May 30, June 23, and June 25, 1960). A pair of adults with five goslings was seen at the mouth of Kasegalik River on July 2, 1959.

HUTCHINS'S GOOSE
Branta canadensis hutchinsi (Richardson)

These are taken infrequently by the Eskimos mainly during the southern migration, when Hutchins's Goose appears to associate with Blue and Lesser Snow Geese, at least on the ground. Specimens were seen in Eskimo tents south of Kasegalik River on September 20 and 22, 1960.

Measurements from a single female (September 22) were as follows:

Weight: 1450 grams. Extended wings: 1230 mm. Total length: 570 mm. Lower bill: 29 mm.

BRANT (NUDLINAK)
Branta bernicla hrota (Muller)

A flock of 12 or 14 Brant were seen on the water by an eider islet in Robertson Bay on June 11, 1960. This was the only sighting and these birds are not known commonly by the Eskimos. However, Brant are reported to have occurred in considerable numbers "until recently", on the Belcher Islands (Manning, 1949), although according to an earlier source (Flaherty 1918) this species only periodically appeared on southern migration. Twomey reported mixed flocks of Brant and Blue Geese flying northward in May and flocks of from fifteen to twenty-five Brant in late August, 1938 (Todd 1963).

BLUE and LESSER SNOW GEESE (KANGOK)
Chen caerulescens caerulescens (Linnaeus)

On May 10, 1959, about twelve were seen flying over our camp on a small island some 15 miles east of Tukarak Island. The first birds in 1960 were observed as large flocks flying northward on May 20. Flights of between 35 and 50 birds were frequent, and a large flight of about 100 birds was observed on May 25. About one-third of this flight was thought to be Snow Geese.

The first bird on the southern migration appeared on August 25, 1960, when a single Snow goose was seen in a flock of approximately twenty-five feeding Canada Geese on the west side of Eskimo Harbour. On September 1, large flights were heading south on a strong northerly wind, and approximately one hundred and fifty Blue and Snow Geese were feeding on a sedge meadow at Spence Harbour.

The birds are taken at most Eskimo camps on the Belchers during this southern migration, particularly on the south coast, where large numbers feed in the marshy areas waiting a following wind or calm conditions before continuing south.

BLACK DUCK (IVURAKRANITAK)
Anas rubripes Brewster

Two Black Ducks were seen flying over the Kasegalik Lake outflow area on May 20, 1960. On May 22 a Black Duck was taken by an Eskimo at a spring fishing lake, about twenty miles to the northeast. A female was taken next day on the East Arm of Kasegalik Lake. Three birds were seen on a small pool of open water on the still frozen Kasegalik River on May 25.

A flightless bird was observed on an island in the Kasegalik River on June 26, 1960, and similarly a flightless adult was seen on June 28, in 1959.

The testes of birds examined at this time were very small:

June 25: 10 $\times$ 5 m. 12 $\times$ 5 mm.

June 27: 13 $\times$ 4 mm. 15 $\times$ 5 mm.

The Eskimo assert that this duck does not breed on the Belcher Islands.

PINTAIL (IVURAK)
Anas acuta Linnaeus.

The open water by French Island was frequented by a pair of Pintails on May 28, 1959. Three days later three birds were seen flying over the open water by the mouth of the Kasegalik River.

A male examined on May 30, 1960, had very enlarged testes. Pairs were seen flying, and on ponds, fairly frequently in the Kasegalik River area during the first weeks of June. By June 18, pairs were being flushed from likely nesting locations bordering streams but the first eggs were not located unil July 21, 1959, when a nest with five eggs was found in willows about one mile north of the Kasegalik Lake outflow.

On July 22, 1960, a female with six downies was seen on a pond by the mouth of Kasegalik River. The female led the young into sedges bordering the pond, then entered into a distraction display, consisting of dropping the wings and jumping vigorously and conspicuously from hummock to hummock away from the pond.

GREEN-WINGED TEAL (GMELIN)
Anas carolinensis

This bird may appear infrequently on the Islands. It was known to one informant, who had shot a specimen in Kipalu Inlet. It was also observed in late summer 1959 (Dr. I. A. McLaren, personal communications).

AMERICAN GOLDENEYE (KUTIKUK, also KUTIKUDLAK)
Bucephala clangula americana (Bonaparte)

Small flocks of males were seen in late June on the Kasegalik River, usually where the current is swift, either above or below rapids. They are often associated with American Mergansers and sometimes Canada Geese. The earliest sighting was on June 13, 1960, when two males flew over the Kasegalik River mouth from the east. The previous year a point on the Kasegalik River about two miles northeast of the river mouth was a favoured spot for Goldeneye, a small flock of about twenty birds being first observed there on June 21.

The expanded river below the falls leading from Kasegalik Lake was also a favoured locality, and on June 16 and 23, 1960, flocks of from fourteen to sixteen and eight males respectively were observed at this place. Testes of a bird examined on June 27, 1959, were very small, measuring 18 $\times$ 6 mm. and 11 $\times$ 5 mm.

On June 31, 1959, several were seen inland on tundra ponds, often associated with American Mergansers.

The last sighting was made on September 28, 1960, when three males were seen on the sea by Snape Island.

OLDSQUAW (AK'AGINERK)

Clangula hyemalis (Linnaeus)

This bird apparently winters in the open water to the south and west of the Belcher Islands. A female was seen on March 1, 1961, in an Eskimo tent at the southwest end of Robertson Bay. It was collected in a tidal current that keeps unfrozen most winters a few miles from the mouth of the Bay.

By the end of April, the Oldsquaw is found on open water among the Islands, such as at French Island, or the open water at the mouth of Kasegalik River. Pairs are seen on most tundra pools during the first weeks of May. A nest with one egg was found near the outflow of the Kasegalik Lake on June 1, 1960, and a pair collected on June 8 had testes and ova in ripe condition. Testes measured 35 × 17 mm. and 34 × 16 mm. Largest ovum measured 24 mm diameter. However, large flights of unpaired birds were still common at this time. Twenty-five at the Kasegalik River mouth were unpaired on June 8 and continued to fly and feed as a flock until June 17 without change. By June 20 the number was reduced to fifteen, only two of which seemed loosely paired during feeding activities on the river.

A nest with one egg was seen on an eider islet two miles west of the Kasegalik River mouth on June 11, 1960. There was no down in the nest at this date, but on June 21 the nest was down-lined and with a total of seven eggs. On July 6, 1960, two more nests were found on this Island, under flat rocks; one nest had a four foot overhang of rock, the other five feet. There were eleven eggs in each nest.

The first young in 1959 were seen on July 10, when a brood of four with an adult female was observed in the Kasegalik River.

Females with broods of eight, four, and eight ducklings respectively were seen on July 7, 17, and 22 within a short distance of the Kasegalik River mouth.

A female with four ducklings was seen in the southwest part of Eskimo Harbour on August 25, 1960.

HARLEQUIN DUCK

Histrionicus histrionicus (Linnaeus)

Manning (1949) reports a skin in the National Museum of Canada, collected on September 2, 1927 by Burwash. According to Manning, on that date Burwash was on a small island a few miles east of the main Belcher Island archipelago.

HUDSON BAY EIDER (MITERK)

Male only (MITERK AMAULIK)

Somateria mollissima sedentaria Snyder

This is an abundantly nesting species with a somewhat localized distribution on the Islands. It winters in large numbers at the floe edge and open water places among the Belcher Islands. Ecological observations on this species will be reported later.

KING EIDER (MITERLUK)

Somateria spectabilis (Linnaeus)

Male (MITERLUK AMAULIK)

Not a common bird in the southern part of the Belcher Islands where some large concentrations of Hudson Bay Eider are nesting. However, it is reported by one informant to have a localized nesting population, in fairly large numbers, on some small islands in the North Belcher group.

A single male was seen on the ice at the mouth of Kasegalik River on June 3, 1959, in a flock of approximately 25 Hudson Bay Eiders. Again, on June 14 two immature birds were seen at the same location, this time in a flock of about thirty Hudson Bay Eiders. On June 17 an immature bird was brought into camp by an Eskimo from the same area of the River.

Only one bird was seen in 1960. This was in the kill of about 50 Hudson Bay Eiders made at the Southwest part of Robertson Bay on June 17.

WHITE-WINGED SCOTER (ANINGESSIK)

Melanitta deglandi (Bonaparte)

The first birds, ten or eleven, were seen on open water by French Island on May 27, 1960.

In 1959, three were seen at this open water pool on May 28, and again on May 29. A single

bird was seen with Eiders and Oldsquaws at the mouth of Kasegalik River on May 31, 1959.

Small numbers in flocks of from four to ten birds were seen on several days during June and July in Robertson Bay and Wetalltok Bay. However, large flocks of white-winged and dark-winged Scoters were seen in Eskimo Harbour in late August. Several hundred birds were estimated to be on the water at the northwest end of the Harbour.

It was maintained by several local informants, that only male birds occur on the Belcher Islands. However, Twomey notes that during the period May 29 until August 2, 1938, males only were seen but after that date four females were sighted in Omarolluk Sound (Todd 1963).

SURF SCOTER
Melanitta perspicilatta (Linnaeus)

These scoters have been recorded as occurring fairly abundantly on the Belcher Islands at various locations, viz. Tukarak Island, Eskimo Harbour, Kipalu Inlet, Wetalltok Bay, and the North Belcher Islands (Twomey and Herrick 1942; Todd 1963).

None were definitely observed in 1959 and 1960, although the large numbers of dark-winged and White-winged Scoters occurring in mixed flocks observed in Eskimo Harbour may have included this species.

AMERICAN SCOTER (ANINGESSIK)
Oidemia nigra americana Swainson

A pair were brought into camp by Esķimos on June 21, 1959, one mile east of Kasegalik River. The gizzard of the male was empty but the female had three small *Mytilus* intact in the gizzard. The ovary and oviduct could not be located. The testes were very small. Right testis: 8 × 3 mm. Left testis: 15 × 6 mm.

On July 4, 1959, eight were seen on the sea one mile east of the Kasegalik River.

In 1960 the only birds seen were those in large flocks (with White-winged Scoters) in Eskimo Harbour during the last week of August. It is not possible to state whether these particular birds were American or Surf Scoters.

AMERICAN MERGANSER (AKPUNGIYORALUK)
Mergus merganser americanus Cassin

Two males were seen on the open water of Kasegalik River by the rapids half a mile east of the river mouth. They were diving at the edge of the fast-ice still covering the river between rapids on May 26, 1960. The previous year a single male had been observed at this place on May 31.

When the river became ice-free the same locations at the heads of rapids or below falls seemed favoured. In 1960, at these points, four males were observed on June 18 and six males and females and seven males and females on June 23 when groups were seen on rapid sections of the river some two miles apart.

In 1959, pairs were frequent along the east bank of the Kasegalik River about five miles or more upstream from the tidal limit.

The first young were seen on August 17, 1960, when an adult and four fledged young were swimming on the sea on the west side of Robertson Bay.

Many were seen flying over the central parts of Kasegalik Lake on August 31, 1959.

RED-BREASTED MERGANSER (AKPUNGIYOK)
Mergus serrator serrator Linnaeus

On May 23, 1960, a male was brought into camp by an Eskimo. It had been collected on the still frozen East Arm of Kasegalik Lake. A bird shot on June 28 had very large testes, measuring approximately 65 × 22 mm. Pairs were first seen on June 7, 1959. A female examined on June 8 had small, but developing ova. It had been feeding in Kasegalik River, and the gizzard contained the spines of sticklebacks (*Gasterosteus*).

A pair was seen on a lake about three miles northeast of the River on June 9.

In 1960 the only pair observed was on a small lake nearly one mile south of the west entrance to Eskimo Harbour, on August 25.

ROUGH-LEGGED HAWK (KRINURAK)
Buteo lapopus s. johannis (Gmelin)

Frequently seen near precipitous inland cliff faces, and also to a lesser extent near coastal cliffs. Three inland nesting sites occupied in

1959 were re-occupied the following year; one 1959 coastal site near the Kasegalik River mouth appeared to be usurped by a pair of Peregrines in 1960 though hawks took up a new site about 150 yards distant on the same cliff.

The Kasegalik River valley presented a number of suitable cliffs and a total of eight locations were noted between the River mouth and source where hawks exhibited territorial behaviour.

The earliest sighting was May 4, 1960, when a pair were seen in the neighbourhood of the Kasegalik Lake overflow. It was not until May 9 that this pair re-occupied the ledge hawks had used the previous year.

On May 30, 1960, a pair of light-coloured hawks were seen attacking a Herring Gull over the mouth of Kasegalik River; they chased the gull far out over the frozen Robertson Bay. That evening one of the hawks at this location was calling in flight in front of the cliff face; the other bird was responding from a ledge about thirty-five feet from the base of the cliff. After some minutes of wheeling flight, both birds occupied the ledge and periods of silence and soft cooing alternated for several minutes.

Nine of the thirteen birds seen in 1960 were judged to be of a "light-phase"; no decision was made on the remainder. Five of the seven birds seen in 1960 were "light". No decision was made on one pair. However, none of these birds were collected and the need for caution in gauging colour phases is recognized.

Three fledged young were raised by the pair nesting at the Kasegalik River mouth in 1959. The young were taken by Eskimos for pets. Two of the three nestlings were seen and marked size difference was noted, as well as plumage difference.

A nest with young was observed less than two miles south of Spence Harbour, on September 1, 1960.

Apart from the relatively large concentration of these birds in the Kasegalik River valley, several sight records were made at other locations. These were one mile north of the Post on Tukarak Island (May 18, 1959); southeast Kasegalik Lake (June 4, 1959); ten miles southwest of the Post (May 28, 1960); southwest Eskimo Harbour (August 28, 1960); and west Eskimo Harbour (August 28, 1960).

PEREGRINE FALCON (KITAVIK)
Falco peregrinus anatum Bonaparte

A single bird was observed flying northward along the central island chain of Kasegalik Lake on May 20, 1960. On May 29, a single bird was seen flying over a stretch of cliff near the Kasegalik River mouth which the previous year had been occupied by nesting Rough-Legged Hawks. As I passed some fifty feet below, on the sea-ice, the falcon wheeled overhead, calling noisily. Next day a pair was observed on the cliff face at the same location. One flew silently inland as I passed below, and when I approached the base of the cliff the second bird flew silently from the cliff face. The lack of commotion was in marked contrast to the behaviour of the previous day.

On June 19, a single bird was flying in the same general location. Three birds were in flight around the cliffs of a prominent hill on the west side of Eskimo Harbour on August 28. Another three birds flew by similar crags a mile and a half south of Spence Harbour on September 1. The last sighting in 1960 was on September 19, when a single bird was observed hovering over the sea a mile east of Kasegalik River. On July 3, 1959, a single bird was observed on a prominent boulder on the cliff top at the south end of the East Arm of Kasegalik Lake. A pair was seen chasing a sandpiper over one of the islands at the south end of Kasegalik Lake on August 18; a pair was again seen on August 31 at the same location.

The species is reported as breeding on the Belcher Islands (Todd (1963).

ROCK PTARMIGAN (AKRIT'I)
Lagopus mutus rupestris (Gmelin)

This is not an abundant bird on the archipelago; very few are taken by the Eskimo in the winters, though more are taken each spring. There does not appear to be much flocking or local seasonal movements: a low density dispersed population seeming the normal situation.

In 1959, betwen May 17 and July 4, ptarmigan were seen singly or in pairs on five separate occasions. In 1960, between April 20 and May 25, ptarmigan were encountered in pairs or singly nine times, and in addition, groups of three, four, and twelve birds were seen once each, in late April and early May. A single bird and a pair were seen during the month of March, 1961.

Territorial behaviour was first observed among ptarmigan near the Kasegalik Lake overflow area in the second week of May. At this time there was abundant snow on the ground, and the all-white birds settled mainly on the snow-patches. A female examined at this time weighed 500 grams and had small developing ova, the largest being 3 mm. diameter. The next week, female ptarmigan were brown flecked, though the males were still completely white. A female of one pair exhibiting territorial behaviour attempted distraction display, but then flew off with the male, before returning some minutes later to the original position. On May 25, a female ptarmigan was examined in Robertson Bay, and the two largest ova each measured more than one centimetre in diameter. At the end of the first week in June, female ptarmigan were in summer plumage, whereas the males were still white. Distraction display by a brown coloured ptarmigan was observed on July 4, and by July 21, a family of two coloured adults and five fledged young was flushed from the tundra near the Kasegalik Lake outfllow area. A family of two adults and seven juveniles were still together on August 17. A pair of adults seen near the Kasegalik River on September 19 had almost completed their moult to winter plumage.

Birds examined in May at the Kasegalik Lake outflow were feeding on willow shoots and *Vaccinium* berries.

SANDHILL CRANE
Grus canadensis

My notes on this species have been mislaid. However one was seen in an Eskimo tent in Wetalltok Bay in May 1959; apparently a few are seen on northward migration at this season, but it is not a frequent visitor.

SEMIPALMATED PLOVER (KODLIKODLIAK)
Charadrius semipalmatus Bonaparte

Several were seen on wet gravel along the Kasegalik River on May 31, 1959. Pairs were observed inland, northeast of Kasegalik River on June 4, and from that day courtship displays were frequently seen in the general area. On June 16 the first nest, with 2 eggs, was found and on July 1 another nest with four eggs was located.

In 1960, the first birds were seen on May 21 in a wet tundra locality some twenty miles northeast of Kasegalik Lake outflow. On June 20 marked distraction display was observed.

A small flock of from six to eight young birds was encountered on August 25, 1960, about one mile south of the west entrance to Eskimo Harbour.

GOLDEN PLOVER
Pluvialis dominica dominica (Muller)

This bird was not known to informants on the Belcher Islands. However, on June 4, 1959, two pairs and one solitary bird were seen inland by tundra pools, between the coast and the south shore of Kasegalik Lake. That same evening six were seen by the coast, adjacent to a stream. There were no more sightings in 1959, and the only record in 1960 was of a solitary bird in fall plumage, seen on marshy ground a mile east of Kasegalik River on September 29.

It has been reported in mid-August on Tukarak Island, and in late August at Eskimo Harbour (Todd 1963).

YELLOWLEGS
Totanus sp.

Listed by Flaherty (1918) as present on the Islands. This species was not known to informants, suggesting that it has the status of an occasional visitor, or small numbers may be present during migration. *Totanus melanoleucas* has been recorded from the King George and Sleeper Islands (Manning 1949); some were seen in Kipalu Inlet, Eskimo Harbour and the North Belcher Islands in August 1938 (Todd 1963).

PURPLE SANDPIPER (LUVILULILAK)

Erolia maritima (Brunnich)

This is the commonest sandpiper and with the Semipalmated Plover, probably the commonest shorebird on the Belcher Islands.

Large numbers were observed by rapids and on the fast ice nearby, along the Kasegalik River on May 31, 1959.

Two pairs were seen inland in the wet tundra between the coast and the south shore of Kasegalik Lake on June 4. The first eggs (4) were found on an island in the Kasegalik River on July 8. By August 18, large flocks were forming inland in the Kasegalik Lake outflow area.

The first bird in 1960 was observed on May 23, and by May 25 several groups of three or four were commonly observed in the Kasegalik River area. No distraction display was observed until May 29, after which date it was frequently witnessed in this locality.

Quite large numbers were seen feeding on the debris at high tide mark on small islands in Robertson Bay on August 17, 1960. The latest date that this species was seen was September 28, 1960, when two birds were on rocks by Snape Island.

PECTORAL SANDPIPER

Erolia melanotos (Vieillot)

This bird has been collected on the Belcher Islands by Murie in late August, 1915; it has also been sighted on Tukarak Island in early August, 1938 (Todd 1963).

WHITE-RUMPED SANDPIPER

Erolia fuscicollis (Vieillot)

This species is reported as being abundant, especially in the North Belchers, in late summer of both 1915 and 1938 (Todd 1963).

BAIRD'S SANDPIPER

Erolia bairdii (Coues)

A single sandpiper seen on a beach in Eskimo Harbour on August 25, 1960, was thought, from the field notes, to be this species.

LEAST SANDPIPER

Erolia minutilla (Vieillot)

This species has been recorded as breeding on Tukarak Island (Twomey & Herrick 1942). It was not observed in 1959 and 1960.

DUNLIN

Erolia alpina (Linnaeus)

A single specimen, of what was thought to be this species, was observed on the beach, on the west side of Eskimo Harbour, August 28, 1960.

NORTHERN PHALAROPE (SAKPAK)

Lobipes lobatus (Linnaeus)

A pair, still in winter plumage, was seen on June 3, 1959, on a small pool on the cliffs overlooking Robertson Bay, in the Kasegalik River area. During the next week pairs or singles were observed fairly frequently on small tundra pools. The first chicks were encountered on July 10, when a pair of adults and three young appeared on a small pond a few hundred yards east of Kasegalik River mouth.

In 1960 pairs were seen on ponds, often with Oldsquaws, on June 1 in the Kasegalik River area. On July 7, a single bird on a pond acted in an excited fashion as I approached, but despite a search no nest, or other bird, could be detected. By July 31, adults in post-nuptial plumage were seen in the locality adjacent to Kasegalik River.

JAEGER (ISSUNGAK)

Stercorarius sp.

Jaegers are reported as periodically visiting the eastern part of the archipelago and some years may undertake breeding, as in 1938 (Twomey & Herrick 1942). They were not present in 1959 or 1960.

Both Parasitic and Long-tailed jaegers probably visit the Islands as both are recorded as present on the King George and Sleeper Island groups immediately to the north of the Belcher group (Manning 1949) and both species were in fact observed in 1938 on the Belcher Islands (Todd 1963).

GLAUCOUS GULL (NAURAK)

Larus hyperboreus hyperboreus Gunnerus

In 1960 the first specimen was seen on May 20 in the outflow region of Kasegalik Lake. The previous year this species was first seen on May 22, when in company with Herring Gulls, a few individuals were seen flying over the tundra south of Kasegalik River.

On May 29, 1960, a pair were seen at the Kasegalik River mouth, on the steep cliffs a pair had frequented the previous year.

What is thought to be a nest of this species with one egg in it, was seen on an eider islet in Robertson Bay on July 2, 1959. This nest occupied the only prominent knoll on the island, although this was only about twenty feet above sea level. On passing close to some very precipitous islands a mile to the north of this low island, several glaucous gulls made very violent attacks on the boat.

On August 28, 1960, six adults and two dusky young birds were seen on the coast west of Eskimo Harbour, adjacent to high cliffs. An adult and juvenile were seen at a similar location two miles south of Spence Harbour on September 1, 1960.

Nesting of this species was reported by Twomey; nests with three eggs were found on two occasions in mid-June on Tukarak Island (Todd 1963).

HERRING GULL (NAURAK)

Larus argentatus smithsonianus Coues

Commonly seen from early May both near the coasts, and also in the vicinity of the Kasegalik Lake.

In 1959, the first gull was seen on May 16, one mile north of the Post, on Tukarak Island. Several gulls, of this species and the preceding, were seen flying over the tundra south of Kasegalik River on May 22, and during the following weeks. Several were encountered during journeys in Omarolluk Sound on May 28, and 29.

Two pairs were seen at the open water below the Kasegalik Lake outflow on May 5, 1960. Pairs and some individuals were seen almost daily in this region and other parts of Kasegalik Lake during May.

TABLE 1. — Herring Gull clutch and egg sizes (mm) Robertson Bay, Belcher Islands

Date	Clutch size	Egg Length		Egg Dia.	
		Mean	Range	Mean	Range
11-6-60	1,1,1,1, 2,2,2,2, 3.	75.8	71.5–82	50.8	48–54.5
17-6-60	Removal of eggs by Eskimos				
21-6-60	2,2, 3,3,3,3.	—	—	—	—
6-7-60	1,2,2,2, 3,3,3,3, 3,3.	77.8	70–85	51.85	48.55

The first nests were seen on June 11, 1960. Data on clutch sizes and egg dimensions are given in Table 1. These nests were situated on a low-lying eider islet in Robertson Bay. When visited on July 6, several eggs were at the point of hatching. Droppings near the nests contained, in large part, lemming remains. Other nests were located on rocks in shallow lakes, and on rocky islets in the Kasegalik River; similar situations in the Kasegalik Lake were probably used by nesting gulls.

Adults and juveniles were seen on an island on the west side of Eskimo Harbour in late August, 1960, and also a few gulls at Wiegand Island.

Numerous adults and juveniles were flying in the vicinity of Snape Island on September 28, 1960.

It was reported that the hand-reared gulls kept in several Eskimo tents as pets, left the Islands in mid-October 1959.

IVORY GULL

Pagophila eburnea (Phipps)

This species is listed by Flaherty (1918) as occurring rarely. However, as Flaherty made no reference to the abundant Herring Gull in his unrepresentative list of Belcher Island birds, it is probable that this record is in error.

ARCTIC TERN (IMMITKROTAILAK)
Sterna parasiadea Pontoppidan

Terns appeared in small numbers in the vicinity of the Kasegalik River mouth on June 22, 1959 and June 20, 1960. This was two to three weeks after the ice had left Wetalltok Bay. A large island in a bay, a mile southeast of Kasegalik River, was the resting place for up to one hundred terns during the summer months. In this general region the small flocks of about a dozen birds were common along the coasts.

A single tern only was seen in the southwest corner of Eskimo Harbour on August 26, 1960. A few days later about six or seven birds were seen flying in Omarolluk Sound a few miles from the trading post on Tukarak Island.

Murie lists this as a common bird in Eskimo Harbour and elsewhere on the Belcher Islands in 1915. He located several breeding colonies; in 1938 Twomey found no evidence of breeding, and only a few individual birds in Omarolluk Sound, Eskimo Harbour and the North Belchers (Todd 1963). Our own records tend to support the changed status of this bird on the Islands since the time of Murie's visit.

BLACK GUILLEMOT (PITSIULAK)
Cepphus grylle (Linnaeus)

In the spring of 1959 and 1960, this species was observed near land on the day following the break-up of the sea ice. It seems probable therefore, that this bird is present at the floe edge elsewhere on the Islands considerably earlier than the dates presented here. Break-up in Wetalltok Bay occurred on June 13 in 1959, and at that time about 26 birds were seen on the ice edge and 20 more swimming on the sea nearby. On June 14 they were seen on the open water at the mouth of the Kasegalik River, though at this time Robertson Bay was still ice covered. One light coloured bird was seen in a flock of about 35 swimming guillemots on June 16. Large flocks were observed swimming on the sea about one mile offshore on June 18 in Wetalltok Bay, and in this region flights of up to 100 birds were infrequently encountered.

In 1960 the first birds were observed on June 4 on the open water at the mouth of Kasegalik River. About one dozen birds were seen, some of which appeared to be paired. On June 11 the ice was sufficiently open in Robertson Bay to allow a canoe crossing to the eider islets there, and during the two mile canoe journey about fifty guillemots were seen on the ice and in the open leads. A nest was found on July 6 on one of these eider islets, beneath a large overhung boulder; each of the two eggs measured 63×43 mm.

On August 17, 1960, large numbers of this species were seen in Robertson Bay. One bird in a small flock was piebald; the wings were normally coloured and the head, back and breast were white.

According to Todd (1963), this bird winters among the Belcher Islands.

SNOWY OWL (OPIK; OPIALUK)
Nyctea scandiaca (Linnaeus)

Owls were more frequently seen in 1960 than the previous year; in both years lemmings were abundant.

In 1959 one was reported flying over the tundra two miles east of the Kasegalik River on May 31. A single bird was seen flying in the same area on June 30.

An owl was shot by an Eskimo in Omarolluk Sound on April 19. One was seen at Haig Inlet on April 25, and another on the ice in central Omarolluk Sound on May 7. On June 2 a pure white individual flew from Kasegalik River westward over Robertson Bay. Two were seen flying over the tundra two miles to the east of Kasegalik River on June 3. A brown juvenile was seen on August 12 near the Kasegalik River mouth, in an area heavily covered by lemming runs.

Two flew over our camp in southwest Eskimo Harbour at dusk, on August 25, and two days later eight brown owls were flushed from a grassy area on the shore a few hundred yards from our tent.

A pair of white owls were seen less than a mile north of the Post on Tukarak Island, and the following day, September 1, a brown owl was seen a mile south of Spence Harbour.

In 1938, it was reported (Twomey & Herrick 1942) that owls could be seen every quarter mile in the interior of Tukarak Island. In 1959

on two crossings of Tukarak Island in early May, no owls were seen, and when they were more plentiful the following year, observations in Omarolluk Sound, where most owls were seen, suggested these birds were at least seven or eight miles apart.

HORNED LARK (KROPANORARUKPAK)
Eremophila alpestris alpestris (Linnaeus)

Two individuals were seen at the Post on Tukarak Island, also several solitary birds and some pairs in the interior of Tukarak Island on May 17, 1959. Courtship displays were noted by the Kasegalik River on May 31.

The following year, a solitary male was seen on May 19 twenty miles northwest of Kasegalik Lake overflow. The first pairs were seen on May 24 by Kasegalik River.

This species was reported as breeding on Tukarak Island in early June, 1938 (Todd 1963).

PURPLE MARTIN
Progne subis subis (Linnaeus)

A bird observed flying north in Omarolluk Sound on May 29, 1959 was not known to the Eskimos; from the brief view obtained, it was thought to be this species.

COMMON RAVEN (TULURAK)
Corvus corax principalis Ridgway

This was not commonly observed, but sightings were more frequent in 1960 than in 1959.

In 1960 one was heard near Haig Inlet (April 25). Another was seen at French Island (May 6); at the mouth of Kasegalik River (August 13), and a pair flying in Robertson Bay (August 17). In Eskimo Harbour a pair was seen a mile south of the west entrance (August 25), and overlooking Kipalu Inlet, a mile south of Spence Harbour (September 1). On September 28 a pair was flying over the sea at Snape Island.

The previous year a single bird was seen flying near the Post on Tukarak Island (May 18) and another solitary bird inland by the cliffs at the southeast corner of Kasegalik Lake (June 4).

Breeding in April has been reported on Tukarak Island where a nest with five eggs was located on a precipitous cliff face (Twomey & Herrick 1942); in that same year, 1938, nests with two eggs (May 10) and four eggs (May 17) were also recorded (Todd 1963).

BROWN THRASHER
Toxostoma rufum rufum

The remains of a bird, not known to the Eskimos, was collected from the shore in Eskimo Harbour, late August 1960. The specimen was later identified by Dr. W. Earl Godfrey, of the National Museum of Canada.

WATER PIPIT
Anthus spinoletta rubescens (Tunstall)

A pipit, first seen in the area near our camp by the Kasegalik River, on May 22, 1959, was in full song by May 30.

The first nest with eggs was found on June 18, 1960, on some vegetated crags overlooking the falls at the outflow of Kasegalik Lake. The same day a second nest, also with five eggs, was found by a small stream two miles to the south. It was situated under a projecting rock, and like the first nest had a south facing aspect. A nest found on June 19 with two eggs, contained three eggs the following day, and six eggs on June 24. It was situated on a well vegetated hillside at the mouth of the Kasegalik River. On June 23 a nest with five eggs was found by Kasegalik Lake. A fledged young bird was seen on July 22.

Several, including juveniles, were seen in the southwest and northern parts of Eskimo Harbour on August 28, 1960, and several more at Spence Harbour on September 1.

ORANGE-CROWNED WARBLER
Vermivora celata (Say)

A single specimen was seen in a willow mat by Kasegalik River on May 22, 1959. On June 1 a specimen was again noted, again in willows at a location about a mile from the earlier sighting. This specimen was collected by Eskimo children, and was unknown to the Islanders. Twomey reports similar accidental records for

the Belcher Islands, when three different species of warbler (Tennessee, Myrtle, and Bay-breasted) were found on Tukarak Island following a storm in late May, 1938 (Todd 1963).

REDPOLL
Acanthis sp

Single birds were seen on May 24 and 26, but from the detailed field notes, were thought to be two different individuals. Both were seen a mile southeast of Kasegalik River.

In 1938, Common Redpolls were seen on Tukarak Island in the spring and early summer; a set of four eggs collected on July 14, 1938, was thought to belong to the Hoary Redpoll (Todd 1963).

LAPLAND LONGSPUR (NASAULIK)
Calcarius lapponicus lapponicus (Linnaeus)

In 1960 the first bird, a male, was seen on May 4, in a small flock of Snow Buntings in the Kasegalik Lake overflow area. Solitary birds (mostly males) were frequently seen during the next week, and pair formation had become widespread by May 26.

On May 24, 1959, the first large flock was seen feeding on willow patches a mile south of Kasegalik River. Some males were still in winter plumage at this time.

This species was seen abundantly in most areas visited, and nests were found on June 21 (3 eggs), June 24 (5 eggs), and July 3, 1959, (two nests, 4 eggs each). The nest found on June 24 contained four normally coloured eggs, the fifth being a pale blue; there was no noticeable size difference.

SNOW BUNTING (AMAULIGAK)
Plectrophenax nivalis nivalis (Linnaeus)

A single male was seen flying north along the east side of Robertson Bay on March 31, 1961, the first sighting of the year according to local informants. A single male was also seen the same day about three miles to the northeast. The next occurrence was on Tukarak Island, April 4, when three or four birds were seen feeding near the Post.

In 1960 single birds were seen or heard about 10 miles south of the Post (April 23), near Haig Inlet (April 25), at the Post (April 27), and at Kasegalik Lake outflow (April 29).

By May 4 a flight of about two dozen birds were feeding on snow-free ridges near Kasegalik Lake outflow (April 29).

By May 4 a flight of about two dozen birds were feeding on snow-free ridges near Kasegalik Lake outflow, and although vocal, no courtship activities were noted. Flights of similar size were frequently noted in the area up until May 10, and by May 12 a few pairs had formed, and some solitary males were singing strongly; no large flights were observed now. Loose pairs were commonly seen during the next two weeks, and on May 26 territorial disputes between males were seen near Kasegalik River.

A fully fledged young bird was first seen on July 22, and large flocks were assembled at the coast on September 21, 1960.

On May 9, 1959, a single bird was observed on the sea ice about 35 miles east of the Belcher Islands. Small flocks (with a few Horned Larks) were seen at the Post on May 17, and a few birds were seen in the interior of Tukarak Island the same day, feeding on *Empetrum* berries. The first distraction display was noticed on May 22 near a pile of boulders in the Kasegalik River area. Quite large flocks, comprising young of the year and young pipits, were seen August 18 through the following week, in the Kasegalik Lake outflow area.

Acknowledgments

The field work during which these observations were made, was undertaken with generous grants from the Carnegie Arctic Programme Committee of McGill University, the Banting Fund of the Arctic Institute of North America, and the Fisheries Research Board of Canada.

Travel arrangements to and from the Islands were greatly facilitated by Rev. S. Wilkinson, Mr. E. May and Mr. G. W. Fyfe of Great Whale River, P.Q.; Drs. E. H. Grainger and A. W. Mansfield, scientists-in-charge of C.G. M.V. "*Calanus*" in 1959 and 1960 and Mr. B. Margetts, Captain, C.G.M.V. "*Calanus*".

Hospitality and assistance was provided by Mr. and Mrs. B. F. McMaster, Mr. M. C. Hampson, and Managers and staff of the Hudson's Bay Company, Great Whale River. A number of Islanders were particularly helpful and together with Dr. P. F. Maycock provided appreciated companionship during different phases of the field work.

The writer acknowledges with grateful thanks his indebtedness to these individuals and organizations.

Literature Cited

Burwash, L. T. 1927. The Eskimo, their country and its resources. An economic survey of East coast of Hudson Bay, etc etc. Canada, Dept. of Interior, N.W.T. & Yukon Branch, Ottawa.

Flaherty, Robert J. 1918. The Belcher Islands of Hudson Bay: Their discovery and exploration. Geographical Review V(6): 432-458.

Harper, Francis. 1958. Birds of the Ungava Peninsula. Univ. Kanas, Misc. Publication No. 17.

Manning, T. H. 1946. Bird and Mammal notes from the east side of Hudson Bay. *Canadian Field Naturalist* 60 (4): 71-85.

Manning, T. H. 1949. The Birds of Northwestern Ungava. *In* A summer on Hudson Bay by Mrs. Tom Manning, London.

Sutton, G. M. 1929. Notes on a collection of birds from Mansel Island, Hudson Bay *Condor* 34 (1): 41-43.

Thibert, A. 1958. English-Eskimo Dictionary. Ottawa.

Todd, W. E. C. 1963. The Birds of the Labrador Peninsula. Univ. Toronto Press.

Twomey, A. C. and **Nigel Herrick.** 1942. Needle to the North. Boston.

Received September 1, 1969
Accepted March 20, 1970

The Reproductive Biology of *Calypso bulbosa* (Orchidaceae)[1]

THEODORE MOSQUIN
Plant Research Institute, Department of Agriculture, Ottawa, Canada

Abstract. It is reported that pollination in the orchid, *Calypso bulbosa* L. cannot be effected without the aid of bumblebees. Pollinia of the orchid adhere to the thorax of the bees in a manner that is difficult for the insect to remove and apparently remain on the insect for many days. Ten species of bumblebees with pollinia attached are recorded. An insect exclusion experiment indicates that *Calypso* is self-compatible. Orchid pollinia of other genera are reported on from some Mexican and Nepalese bees.

Introduction

While studying the reproductive biology of wild plants in the area of Banff National Park, Alberta, in 1968, I set out to determine the breeding system and pollinator relationships of the locally abundant Venus'-slipper, *Calypso bulbosa* L. This showy, pink-flowered orchid has a circumboreal distribution, and, in the Banff area, was frequently encountered in the shady, lodgepole pine forests of the lowlands along the Bow River between Banff and Eisenhower Junction.

In 1968, plants of *Calypso bulbosa* began flowering in the last weeks of May, attained peak flowering about June 11 and all flowers had either withered or developed seed-containing ovaries by July 1. Flowering phenology depends to some degree on site for in some locations, flowering took place at least a week earlier than at others.

Reproduction is both by seed and by vegetative means. According to Morris and Eames (1929) *Calypso* "began its life cycle in late summer by producing a solitary green leaf which winters through; then in late May or June (of the following season), when the leaf begins to fade the bulb produces an erect flowering stem surmounted by a single blossom . . ." Once established, plantlets spread by coralline rhizomes located below the tuber. A detailed description of tuber and rhizome development is given by Mousley (1924, 1925). The importance of vegetative reproduction is indicated by the fact that flowering stalks usually occur in closely spaced colonies ranging in size from a few individuals to circular patches many feet in diameter and containing many dozens of flowering shoots. Presumably, these circular patches often represent vegetative growth from one individual.

The size and structure of the flowers are such that they appear to be adapted exclusively to pollination by bumblebees, and evidence presented in this paper indicates that this is indeed the case. The flower is shaped like a slipper and has one operculate anther containing two pollinia, each of which has two lobes. The anther is located just above the entrance to the flower and just in front of a small ridge while the stigmas are located just behind the ridge as is well-illustrated in Correll (1950). The anther is deciduous, being easily removed with the slightest effort or pressure. If left untouched, however, the anther will remain undehisced in its original position until the flower withers. Because of the relative positions of the anther and stigmatic surfaces there is no way in which self-pollination can occur without external aid. The flower contains no visible nectar. In the Banff region unpollinated flowers remain fresh and unwithered for about three weeks, an observation that agrees with that of Nylander (1922, 1935) on plants in Maine, U.S.A.

The observations recorded in this paper were made in two locations. First, in the immediate vicinity of the Mt. Eisenhower Forest Research Station, 20 miles WNW of Banff and second, within a mile of Johnsons Canyon, a tourist resort some 15 miles WNW of Banff. Flowering phenology at the first locality was about one week ahead of that at the second. Observations at the Mt. Eisenhower site were

[1]Contribution Number 754 of the Plant Research Institute.

made mainly on May 26 and at the Johnsons Canyon site on June 7. At both localities plants had already been in flower for about a week.

Insect Exclusion Experiment

This experiment was conducted at the Mt. Eisenhower locality. Its purpose was to establish the breeding system of the species. Mature buds of 10 individual flowers, each on a different colony were bagged to exclude insects. After the flowers opened fully in the bags, five were mechanically self-pollinated by removing the pollinia and depositing them on the stigmas of the same flower. Four of the flowers so selfed developed a large ovary, each containing hundreds of tiny seeds. The fifth was destroyed by a wild animal. The five flowers that were not mechanically self-pollinated, eventually withered and died. From this experiment, it can be concluded that in the Banff region the species is self-compatible but the flowers require the assistance of animals to be pollinated.

Observations on Natural Pollination

To determine the mechanism and the frequency with which effective pollination takes place under natural conditions, two kinds of observations were made. First, a total of about 6 hours were spent between 10 a.m. and 3 p.m. in search of potential pollinators in an area covering some 15 acres and containing several thousand flowers. During the periods of observation the weather was mostly sunny and mild, and insects were visiting *Salix* and *Dodecatheon* colonies in the region. *Dodecatheon* was at the peak of its flowering but only one or two species of *Salix* were in flower. Neither *Dodecatheon* nor the particular species of *Salix* in flower at this time were common in the area. Not a single potential pollinator was seen visiting the *Calypso* populations.

The second kind of observations on natural pollination were made by direct examination of pollinia on individual mature flowers. As pointed out above the anther of this orchid is deciduous and easily disturbed or removed. Flowers at both the Eisenhower Research Station and the Johnsons Canyon localities were examined on hands and knees to determine the disposition or fate of their anthers and/or pollinia. At both localities the flowering of plants was about at its peak, most flowers having been opened for about a week. At the Eisenhower locality 94 flowering stalks of about two dozen colonies covering some 5 acres were examined. In 54 of these flowers the anthers were in place and pollinia still enclosed, in 5 the anther was dislodged with the pollinia hanging down, in 14 the pollinia were missing (removed) and in 21, pollinia were on the stigmas. In this area, therefore, roughly 43% of the flowers had been visited by animals, presumably bumblebees and some 22% of the flowers had been successfully pollinated.

In the second population at Johnsons Canyon, 1,560 plants were examined in a similar way on June 7. The colonies in this area are larger and in some places give a pink color to the forest floor. The observations were made over an area of roughly 10 acres and almost all plants seen were scored. Of the 1,560 flowers, only 160 (10.4%) had pollinia that were either dislodged, missing or on the stigmas; 89.6% of the flowers had apparently not been visited by insects.

Observations on Bumblebees

The observations of bumblebees visiting species other than *Calypso* provide incontrovertible evidence that these insects are the chief if not the only pollinators of the orchid. Some of this evidence is illustrated in Figures 1, 2 and 3 and is included in Table 1. This evidence was accumulated unsuspectingly while making general collections of pollinators on other flowering species. Of the bumblebees carrying pollinia on their thoraces, 8 were captured on *Dodecatheon radicatum* Greene, 9 on *Taraxacum officinale* L., 4 on *Dryas drummondii* Richards, one on *Rubus chamaemorus* L., 3 on *Salix*, 3 on *Fragaria virginiana* Duchesne and one on *Oxytropis campestris* (L.) DC. Some bees had the pollinia of 2 or more flowers attached to their thoraces; others bore evidence of having removed pollinia from the front of their thorax. Evidently, the bees can readily remove pollinia from the front of the thorax but not from the rear.

FIGURE 1. Bumblebees showing position and mode of attachment of *Calypso* pollinia on thorax. Upper three bees with pollinia and lower three without. Top row from left to right: *Bombus occidentalis* Greene, *Pyrobombus bifarius nearcticus* (Handl.) and *B. occidentalis*. Bottom row from left to right: *B. occidentalis*, *P. bifarius nearcticus* and *P. melanopigus* (Nyl.) All are queens. The head of a pin is visible on each insect.

A total of 32 bees with pollinia fixed on their thoraces were collected in the summer of 1968 (Figure 1). Nearly all the bees carrying pollinia were queens, this being due probably to the fact that queens come out of hibernation in the spring while the first workers do not start emerging in significant numbers before June 15, when *Calypso* is near the end of its flowering period.

To determine whether bumblebees from other parts of the range of *Calypso* visited this orchid, I examined the bumblebees assembled in the Canadian National Collection at Ottawa. Perhaps 50,000 specimens from North America and 9000 specimens from Eurasia were examined. Although *Calypso* has a large distribution area in Eurasia, none of the bumblebees from there carried pollinia of this orchid. In North America, however, 39 of the bumblebees carried pollinia that unquestionably came from this orchid. These are listed below by genus and species.

Pyrobombus pleuralis (Nyl.) Elkwater Park, Alberta, May 22 and 23, 1952 (9) and June 6, 1952 (1); Banff, Alberta, May 21, 1915 (2); Eisenhower Junction, Alberta, July 4, 1952 (1); Norman Wells, N.W.T., June 9, 1953 (1); Fort Nelson, B.C., June 8, 1948 (2); Sidney, B.C., May 2, 1915 (1); Kitsap County, Washington, June, 1956 (2) (all queens).

Pyrobombus centralis (Cress.). Vernon, B.C., May 15, 1920 (1); Conconully, Washington, May 29, 1965 (1) (both queens).

Pyrobombus couperi (Cress.). Mistassini, Quebec, June 30, 1956 (1) and June 27, 1956 (2) (all queens).

FIGURE 2. Enlargement of *Pyrobombus bifarius nearcticus* showing pollinia.

Pyrobombus frigidus (Smith). Elkwater Lake, Alberta, May 22, 1952 on *Taraxacum* (2); May 22, 1952 (2); Mistassini, Quebec (1) (no date); Deadman's Creek (near Kamloops), June 11, 1950 (1) (all queens).

Pyrobomus mixtus (Cress.). Elkwater Park, Alberta, May 22, 1952, on *Ribes* (3 queens); Royal Oak, B.C., May 16, 1917 (1 queen); Blueberry, B.C., June 4, 1948 (1 worker).

Bombus lucorum moderatus Cress. Banff, Alberta, June 21, 1915 (3 queens).

Pyrobombus spp. Waterton Lakes National Park, June 17, 1961 (2).

Psythyrus insularis (Smith). Golden, B.C., May 17, 1915 (queen).

In addition to the above, a worker bumblebee believed to be *Bombus terminalis* Smith, collected in Nepal at 27° 58′N, 85° 00′E, on May 27, 1967, at 11,100 ft. had pollinia very similar to those of *Calypso* fixed on its thorax. Apparently, however, *Calypso* does not grow in the Himalayas. Several large bumblebees from Nepal with large, long, orchid pollinia are also in the Canadian National Collection. One of these is a queen of *Bombus festivus* Smith. Also a specimen of *Megabombus* sp. from Ajijic, Jalisco, Mexico, collected on January 22, 1967 carried a large pollinium. A female *Xylocopa* sp. from 4.5 miles west of El Palmito, Mexico, collected by J. F. McAlpine, July 25, 1964, carried one pollinium.

Discussion

Based upon observations of pollinia fixed on bumblebees and on disturbances of the flowers of *Calypso bulbosa* it is clear that this orchid is pollinated by bumblebees and that pollination is affected in the following way. The bee seeing a flower at a distance alights at the

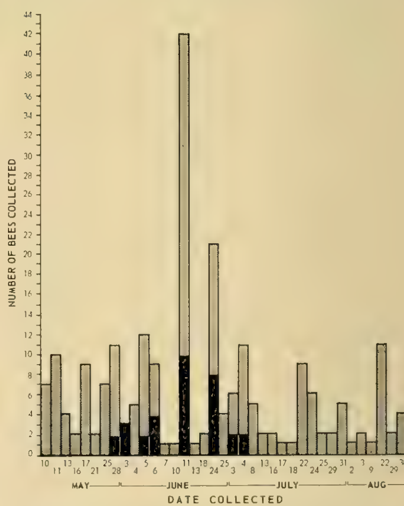


FIGURE 3. Histogram showing total number of bumblebees collected on all plant species in the Banff region during the summer of 1968, together with the dates of collection. The black portion of the histogram bars showing proportion of bees that carried pollinia.

TABLE 1. — Bumblebee species carrying pollinia of *Calypso* on their thoraces[1] and plants on which the bees were captured

	Dodecatheon radicatum Greene	*Taraxacum officinale* L.	*Dryas drummondii* Richards.	*Fragaria virginiana* Duchesne	*Rubus chamaemorus* L.	*Salix* spp.	*Oxytropis campestris* (L.) DC.
Pyrobombus pleuralis (Nyl.)	2 queens	2 queens 1 worker	3 queens				1 queen
Pyrobombus bifarius nearcticus (Handl.)	6 queens	1 queen		1 queen 1 worker	1 queen	4 queens	
Pyrobombus frigidus (Sm.)		1 worker		1 queen			
Pyrobombus mixtus (Cr.)		1 worker	1 queen				
Bombus occidentalis Grne.		1 queen				2 queens	
Megabombus californicus Sm.		1 queen					
Psithyrus insularis (Sm.)		1 female					

[1]All bees are deposited in the Canadian National Collection, Entomology Research Institute, Department of Agriculture, Ottawa.

entrance and as it begins to enter, the front of its thorax presses against the deciduous anther which then becomes dislodged and/or dehisced forcing the waxy pollinia against the front of the hairy thorax. If the pollinia stick to the thorax then as the bee enters the flower its thorax would carry the pollinium into the flower. Due to the size of the flower most bumblebees would enter only about half way. When the bee is in the half-way position the pollinia on the thorax will be in the right place to get caught against the sticky stigma. The bee now finds that the flower contains no nectar and begins to back out; thereby the back of its thorax becomes apressed against the pollinia and the latter against the stigmatic surfaces. The pollinia can then become permanently fixed against the back of the thorax or remain stuck into the stigmas. The bee then goes on to visit a second flower and a third but soon abandons *Calypso* for other species having learned the futility associated with visiting this orchid. The fact that bumblebees are relatively intelligent (Plath 1934; Free and Butler 1959) and capable of learning, would explain why these bees were not actually observed visiting wild plants of this species.

Nylander (1935) noted that in Maine "the flower of *Calypso* is attacked by many birds and other animals and in over 40 years of careful observation of it on my farm and elsewhere, I have not seen a dozen seed pods fully ripened." My own observations at Banff indicate that the principal reason for only some pods in a population setting seed is that the large percentage of flowers are never visited by pollinators and hence remain unpollinated. This observation is in agreement with those made by Mousley (1924) near Hatley, Quebec. Mousley found that of 50 plants examined, only 3 developed capsules.

Cockerell (1915) made the following observations on this interesting orchid in the state of Colorado:

> "On June 8, 1914, my wife and I were able to study this plant in life at Gresham, Colorado. It grew on a damp hillside with a north exposure, under *Populus tremuloides* and young Engelmann spruce, with *Arnica cordifolia* Hook., *Chamaenerion angustifolium* (L.) Scop., and *Fragaria*. We were particularly anxious to see the process of pollination, but in this we were disappointed, owing to the bad weather. We saw no insects on the

orchids, but a few *Bombus* were flying around. There can be little doubt that the work done by *Bombus*, which bending down (almost standing on its head) to get the nectar, would receive the pollen on the upper side of its thorax."

It is clear from this description that the Cockerells did not see any pollinators visiting *Calypso*, even though they searched. From their description of the flower, it would seem that in Colorado the open mouth of the flower points upwardly rather than more or less horizontally as at Banff. The statement that *Calypso* contained nectar was apparently only an assumption.

This study has indicated that at least 10 species of bumblebees visit *Calypso* flowers. Of these, the wide-ranging *Pyrobombus pleuralis* seems to be the most important in pollinating this orchid although at Banff (Table 1), *P. bifarius nearcticus* was important.

It is of interest that 8 of the pollinia-carrying bumblebees were caught on another pink-flowered species, *Dodecatheon radicatum*, even though the latter was not particularly common in the region. Presumably, the bees, accustomed to obtaining rich pollen rewards from *Dodecatheon* (Mosquin, unpublished) would be preconditioned to respond to pink flowers and hence might often mistaken *Calypso* for *Dodecatheon*, at least at a distance.

Of all the bees collected by A. R. Brooks on May 22 and 23 at Elkwater Park, Alberta (see above), 5 were taken on *Ribes*, 6 on *Taraxacum officinale* and 3 on *Thermopsis rhombifolia* (Nutt.) Richards. In view of the close association of bumblebees with *Calypso* pollination it seems clear that the current widespread circumboreal distribution of this beautiful orchid would probably be impossible without the help of bumblebees in affecting seed set.

The finding that pollinia occasionally occur on various tropical and subtropical bees indicates that, like *Calypso*, other orchids may have evolved floral mechanisms that require specific groups of bees to pollinate them effectively.

Acknowledgments

I am grateful to Dr. H. E. Milliron, Entomology Research Institute, Department of Agriculture, Ottawa, for identifying the named bees and for helpful comments on the manuscript.

Literature Cited

Cockerell, T. D. A. 1915. Notes on Orchids. Botanical Gazette 59: 331-333.

Correll, D. S. 1950. Native Orchids of North America north of Mexico. Chronica Botanica, Waltham, Mass., U.S.A. 400 pp.

Free, J. B. and **C. G. Butler.** 1959. Bumblebees. Collins, London, and MacMillan, N.Y. 208 pp.

Nylander, O. O. 1922. Life History of the *Calypso*. Maine Naturalist, Volume 11.

Nylander, O. O. 1935. Our Northern Orchids. Star-Herald Publishing Company, 16 p. + introduction and preface (photostat filed at library, Plant Research Institute, Department of Agriculture, Ottawa).

Morris, F. and **E. A. Eames.** 1929. Our Wild Orchids. Charles Scribner's Sons, N.Y. 464 pp.

Mousley, Henry. 1924. *Calypso*. Journal of the New York Botanical Garden 25: 25-32.

Mousley, Henry. 1925. Further notes on *Calypso*. Torreya 25 (3): 54-59.

Plath, O. E. 1934. Bumblebees and their ways. MacMillan Co., N.Y. 201 pp.

Received November 15, 1969
Accepted December 30, 1969

Occurrence of the Harbour Seal, *Phoca vitulina*, Linnaeus in the Thlewiaza River, N.W.T.

BRIAN BECK, THOMAS G. SMITH, ARTHUR W. MANSFIELD

Fisheries Research Board of Canada, Arctic Biological Station, Ste. Anne de Bellevue, Que.

Abstract. Five seals were seen in Edehon Lake on the Thlewiaza River during the period 20 August to 7 September 1968. The only specimen taken was an 8-year-old male harbour seal *Phoca vitulina* which had been feeding heavily on fish and was in excellent condition. An aerial survey of the river system from Sealhole Lake to Hudson Bay showed that, even though harbour seals might live in the lakes and river the year round, they are not isolated from the marine environment.

The freshwater habits of the harbour seal have been well summarized by Doutt (1942) and Harper (1961). More recently Mansfield (1967) has reviewed the distribution of this species in the eastern Canadian arctic and commented on its occupation of the rivers draining into western Hudson Bay. Its presence in the Thlewiaza River was suspected following reports from G. W. Malaher, former Director of Wildlife, Department of Mines and Natural Resources, Winnipeg, Manitoba, that seals had been seen in two lakes forming part of the river system. In order to substantiate these reports and identify the species of seal concerned, Beck and Smith carried out a field study during the period 20 August to 7 September 1968.

Results

The Thlewiaza River begins its 150-mile course in Sealhole Lake, the northeastern extremity of Nueltin Lake, at an altitude of 876 feet and winds its way through Edehon Lake (540 ft.) and Ranger Seal Lake (approximately 300 ft.) to the western shore of Hudson Bay.

The field study began in Sealhole Lake on 20 August. The first camp was established on the south side of the lake (60° 48′ N, 98°47′W) about 5 miles from the rapids leading out of Neultin Lake (Fig. 1). A 3½-inch nylon mesh net was set within sight of the camp since seals had been seen taking fish from nets during commercial fishing operations on this lake three

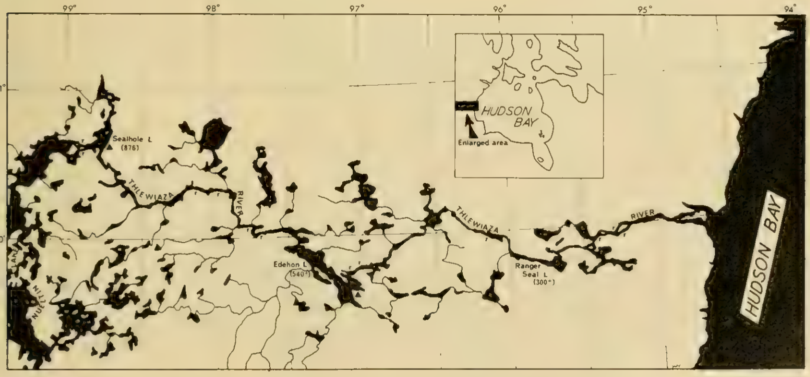


FIGURE. 1. Nueltin Lake and the Thlewiaza River system.

years previously (M. E. Bogart, personal communication). In addition to the fish net, a 14-inch nylon seal net was set near the area of turbulent water at the inflow from Nueltin Lake.

In the period 20-23 August a detailed search of the lake was carried out from an inflatable rubber boat powered by an outboard motor. The whole shoreline was examined from a distance of 200 ft. to ensure that seals basking on rocks would be seen. All inlets were entered as far as possible. On calm days the numerous islands were circumnavigated and the deep water areas searched. No seals were seen on Sealhole Lake during the entire period spent there.

On 25 August camp was moved down stream to an island at the eastern end of Edehon Lake (60° 20′ N, 97° 05′ W), a drop in elevation of 340 ft. Six rapids, each including areas of relatively slow water, were counted in the section of the river between the two lakes. A search was made in the area of the outlet from Edehon Lake (Fig. 1), and a seal was seen in a narrow rocky channel on the north shore. The seal displayed extreme nervousness at it was approached and swam away without offering the opportunity of a shot. Later in the day two seal nets and a fish net were set where the seal was sighted (60° 22′ N, 97° 06′ W). On visiting the nets next day, a seal was observed basking on a small rock in the middle of a shallow passage. A shot was fired at the animal, but it was not fatally wounded and escaped.

On 28 August two seals, a pup and probably an adult female, were seen feeding from the fish net. The pup became entangled in the net but tore free as it was approached; then both animals quickly swam out of sight to the northwest. The nets were visited again on 30 August but this time they were approached from the landward end. Two seals were seen feeding from the

FIGURE 2. Adult male harbour seal (PV 44) taken from a net in Edehon lake on 31 August 1968.

fish net but they disappeared before it was possible to shoot at them.

While moving camp from the island to the netting site on 31 August, a seal was seen feeding in the shallows near the island. It took fright and quickly disappeared. Shortly after camp had been erected in the new location, a seal was seen near the surface entangled in one of the seal nets. It was quickly killed by a shot through the body.

The specimen proved to be a male harbour seal (*Phoca vitulina*) measuring 168 cm in a straight line from nose to tail, 116 cm in maximum girth, with a total blubber thickness of 3.5 cm measured over the sternum. Total weight less blood was 84.4 kg which included 26.8 kg of skin and blubber. The testes weighed 35 g each. The stomach weighed 6.8 kg and contained 8 fish: 5 lake trout *Salvelinus namaycush*, 1 whitefish *Coregonus clupeaformis* and 2 fish which were too digested to be identifiable.

The animal was is full moult. The dorsal pelage was dark grey in colour flecked with dark patches and overlain with a whitish network, occasionally formed into small rings and loops (Fig. 2). The flanks were lighter in colour with more off-white and fewer dark patches, the pattern continuing onto the belly with a further lightening in colour.

The skull and lower jaw were collected and later cleaned in the laboratory. From a longitudinal section of one of the lower canine teeth the seal was estimated to be 8 years old (Mansfield and Fisher, 1960).

TABLE 1. — Comparison of the jaw angles of *Phoca vitulina mellonae* and the harbour seal from the Thlewiaza River with jaw angles of two samples of *P. v. concolor.*

	(1) *P. v. mellonae*	(2) Thlewiaza seal
	Carnegie Museum No. 15215	PV 44
Jaw angle*; length	14°; 127 mm	25.5°; 145 mm
Number of jaws for comparison	21	10
Range of lengths	120–135	135–148
Range of angles; mean	14°–41°; 32.42°	25.5°–44.7°; 38.01
Deviation of (1) and (2) from mean	18.42°	12.51°
Standard deviation (s)	6.99	11.13
t value (dev/s)	2.63	1.10
Probability of obtaining value from one-tailed t-test	0.008	0.154

*Measured between vertical and line joining condyle and alveolus of canine tooth when jaw is standing with condyle and coronoid process on base line (see Mansfield, 1967).

Discussion

Five individual harbour seals were seen during the course of this study. All were sighted in Edehon Lake, though there is every reason to believe that seals could easily move up river to Sealhole Lake. In fact seals were sighted on six separate occasions during the commercial fishery at Sealhole Lake in 1964 (M. E. Bogart, personal communication).

Reports about the presence of seals in winter are confusing. Most reports confirm their presence, though one long-term Indian resident of Sealhole Lake denied ever having seen seals at this time of year (M. E. Bogart, personal communication). There is no evidence that the seals actively maintain breathing holes in ice and it is believed that the name Sealhole Lake originated, not from this habit, but from the presence of seals in caves or holes in rock ledges at the north end of the lake.

It appears likely that seals could winter in the lakes since there are rapids and areas of turbulence where the river flows into and out of the lakes. However, should winter residence in the lakes prove impossible, there appear to be no rapids or other obstacles which might impede the free passage of seals down to the sea. This was confirmed by making a low altitude (200 ft.) aerial survey of the river from Sealhole Lake to Hudson Bay at the end of the field study. Thus there is no reason to assume that these small populations of seals are isolated from the sea, though individuals might be born and spend most or all of their lives in fresh water.

The specimen collected was in excellent condition with a high blubber to body-weight ratio. It would appear from the stomach contents that fish are readily available to harbour seals in the river system. The sighting of a pup also suggests that there is successful reproduction in the freshwater habitat.

Morphologically the specimen does not appear to differ from other harbour seals taken in the arctic though the coronoid process of the lower jaw appears to be unusually long, a characteristic considered by Doutt (1942) to be a measure of sub-specific distinction in the Ungava Lake seals *P. v. mellonae*. In order to determine to what extent the jaws of our specimen and Doutt's specimen differ from that of other harbour seals, we have constructed two distributions of jaw angles from a selection of jaws collected in both the eastern Canadian arctic and the Maritime Provinces.

Statistics derived from the two groups of jaws are shown in Table 1. Each group contains jaws of approximately the same length in an attempt to avoid errors due to widely differing ages. A t-test shows that, though the jaw angle of *P. v. mellonae* is significantly different from others in its size range ($p = .008$), the Thlewiaza specimen is not unusual in this respect ($p = .154$). Thus the suggestion that seals in the Thlewiaza River are different from their coastal relatives is not upheld by the one specimen obtained so far.

Literature Cited

Doutt, J. K. 1942. A review of the genus *Phoca*. Annals of the Carnegie Museum 29: 61-125.

Harper, F. 1961. Land and freshwater mammals of Ungava Peninsula. The Allen Press, Lawrence, Kansas. 178 p.

Mansfield, A. W. 1967. Distribution of the harbour seal, *Phoca vitulina* Linnaeus, in Canadian arctic waters. Journal of Mammalogy 48(2): 249-257.

Mansfield, A. W., and **H. D. Fisher.** 1960. Age determination in the harbour seal, *Phoca vitulina* L. Nature 186(4718): 92-93.

Received March 31, 1970

Accepted July 17, 1970

Winter Predation of Golden Eagles and Coyotes on Pronghorn Antelopes

ELDON H. BRUNS

Biology Department, University of Calgary
Calgary, Alberta

Abstract. Interactions of pronghorns (*Antilocapra americana americana* Ord) with coyotes (*Canis latrans latrans* Say) and Golden Eagles (*Aquila chrysaetos* Linnaeus) were recorded during 360 hours of pronghorn observation. Coyotes do not appear to prey selectively on wounded or aged animals. Pronghorns are relatively indifferent to the approach of coyotes during severe winter conditions. A Golden Eagle was observed killing a pronghorn having an estimated live weight of 70 pounds. The pronounced "bunching" behaviour of pronghorns alarmed by aerial disturbances suggests that Golden Eagle predation on pronghorns may be of evolutionary significance.

The period January 6th to April 13th, 1969 was spent observing pronghorn antelopes *Antilocapra americana americana* Ord., in a 975 mi^2 (2,525 km^2) area of south eastern Alberta and northern Montana. During this period there were opportunities to observe four interactions between pronghorns and coyotes, *Canis latrans latrans* Say, and eight interactions between pronghorns and Golden Eagles, *Aquila chrysaetos* Linnaeus. The interactions with coyotes resulted in the following: one pronghorn kill, one case of active pursuit, one case of a herd running from three coyotes (no pursuit), one case of a coyote being watched intently by some members of a herd (the coyote left without causing further disturbance). Eagles were involved in the following: one case of "bunching" pursuit and kill, three cases of alarm (heads raised watching eagle) and "bunching", four cases of alarm only.

The number of pronghorn-coyote interactions observed during 360 hours of pronghorn observation may be lower than the number expected to occur under natural conditions. This was due to the flat topography of the area and the extremely wary nature of the coyotes after they had located a human. No particular effort was made on my part to remain undetected by the coyotes. Rather intense hunting for coyotes also took place in the area between February 4th and March 3rd, during which at least 31 coyotes were killed. In all, 63 sightings of coyotes and 47 sightings of golden eagles were recorded during the study, however there was no means of knowing how often the same animals were recorded.

It is commonly accepted that coyotes are quite capable predators of young pronghorn fawns (Buechner 1950 and others). There are also many accounts of adult pronghorns being killed by coyotes during the winter when snow conditions make travel difficult for pronghorns (Buechner 1950; Rand 1947). In Adolph Murie's opinion (1940), prey animals taken by coyotes were the sick and the aged; moreover, instances of pronghorns being chased by coyotes were not considered important. The following observations made during this study would suggest both points may not be valid generalizations.

That coyotes do not always prey selectively on wounded or aged animals, even during extreme environmental conditions, is evident from the following observations. On January 15th a herd of 104 pronghorns which I had been observing for four hours was approached from downwind by two coyotes. This herd contained a female fawn with wounds in the throat area and a male fawn which had a badly crippled right hind leg. The latter was seen lying down at every opportunity and lagging behind other animals while feeding and walking. A coyote was first seen walking toward the herd at 14:14 M.S.T., while the pronghorns were scattered over a sagebrush flat where they had been feeding for the past hour. There was 6.3 inches (16 cm) of snow in the area up to 12 inches (30 cm) in drifts behind sage bushes, with a

0.4 inch (1 cm) thick crust on the surface which would not support running pronghorns or coyotes. The temperature was —10°F (—23.3° C) and the wind velocity was 12 mph (19 kmph). The coyote made a circuitous up-wind approach toward the centre of the herd. Having walked to within fifty paces of the herd it made a number of short hesitant walks back and forth parallel to the edge of the herd. This action lasted for two or three minutes, probably long enough for the coyote to detect a crippled animal in the feeding herd; if that was its intention. With a sudden rush, the coyote was headed for the nearest members of the herd. The herd immediately made a short but fast run away from the coyote. Within a few paces, the coyote grabbed a female fawn by the right hind hock. The only response of the pronghorn was to try and pull away. The struggle continued for less than a minute, when a second coyote appeared. This coyote had not been seen previously. It ran straight toward the struggling pair and promptly lunged at the pronghorn's head region. In a few seconds the coyote clamped its jaws over the fawn's muzzle quickly toppling it to the ground. Within two minutes the fawn had stopped struggling and both coyotes commenced feeding on it. The coyotes left the carcass an hour and seven minutes later, whereupon I examined it. The nasal and maxilla bones were crushed, the throat was unmarked, the flesh of the left ribs, left front leg, vertebrae and abdomen was eaten. The short struggle, lack of blood around the site and a considerable pool of blood remaining in the body cavity suggested that the pronghorn had died of suffocation rather than hemorrhage. The prey was estimated to have a live weight of approximately 70 pounds (31.7 kg). It is interesting to note that the pronghorns were not unduly alarmed by the approach of the coyotes. They offered no collective or individual defence and they resumed feeding shortly after the kill. The herd, including two wounded animals, appeared indifferent to the presence of the coyotes feeding on the carcass within 50 paces of them.

Only two of the four coyote-pronghorn interactions resulted in serious capture attempts, and only one in a kill as just described. The other appeared to be a trial run of the herd by coyotes with a readily available food alternative.

On Janury 16th three coyotes from a pack of six were observed attacking the same herd at 09:38. The first coyote walked to within a short distance of the herd before making a run at the nearest members. The herd ran briefly and then stopped in a group to observe the coyotes. At 09:44 two other coyotes joined the first, and the herd was chased out of sight into a coulee. At 09:45 a female pronghorn was seen trotting away from the others. She did not rejoin the herd until three minutes later. During this time the three coyotes had been loping after the running herd. By 09:50 the coyotes had stopped chasing the herd and had laid down. At 09:54 the pronghorns also began lying down a few hundred paces from the coyotes. At 11:12 the pronghorns rose and walked out of sight. The coyotes did not leave their beds until 11:56, at which time they walked off in the opposite direction to join another member of the pack. The snow conditions were the same as on the previous day. The temperature was 0°F (—17.8° C) and the wind velocity was 0—5 mph (0—8 kmph). The attack had been made upwind as in the previous case. There was no apparent reason for the coyotes not making a kill during this attack. They did not appear to have trouble overtaking their prey and the pronghorns did not repel them. These coyotes went to a carcass a half mile (0.8 km) distant and fed.

Apparently pronghorns are relatively easy prey for coyotes during adverse snow conditions. It is interesting to speculate on the reasons for the pronghorn's lack of weariness of approaching coyotes since this gives the coyote a definite advantage. It is probably due to the inexperience of pronghorns with coyotes in relatively deep snow. On bare ground, or during periods of light snow cover, the pronghorn is quite capable of outrunning a pursuing coyote. Pronghorns can be aggressive toward coyotes during the summer. Individuals have been observed chasing coyotes (Einarsen 1948; Van Wormer 1969). It is reasonable to assume that such experiences would cause pronghorns to

have a rather indifferent attitude toward coyotes during the winter. The low temperatures and deep snow may act as proximate factors by limiting mobility as well as more subtle ultimate factors by limiting available energy for high intensity escape responses.

In these cases it did not appear that any particular animal other than the closest was selected for pursuit. However, this would require quantitative data for verification. In the case of cheetahs (Schaller 1968), it was found that smaller animals in a herd were selectively preyed upon. Rand (1947) mentioned instances where coyotes apparently killed pronghorns of all age classes.

The golden eagle is seldom considered a predator of pronghorn antelope in winter. This is due to the unusually disproportionate body size between prey and predator and the fact that golden eagles probably do not prey on pronghorns during this season unless their normal prey and carrion are scarce. Many would consider it highly unlikely that a 7 to 14 pound (3.2-6.4 kg) raptor could kill a ruminant weighing over 60 pounds (27.2 kg). I found during an unusually severe winter on the southern Alberta prairie (Bruns 1969) that pronghorns are much more wary of aerial predators than they are of coyotes. The following account describes the reaction of a pronghorn herd to a golden eagle attack and kill.

On January 11th, a herd of 61 pronghorns which I had been observing for 2.5 hours suddenly ceased resting and ran together forming a very tightly packed group. A golden eagle had flown over the herd and landed on a rock within 50 paces of the herd. The eagle remained on the rock for two minutes. During this time it watched the herd closely. All members of the herd remained in the "clump", facing in the eagle's direction. At 12:55 the eagle arose from the rock and flew directly at the herd. Immediately, three of the nearest members of the herd ran a few paces toward the oncoming eagle and made three or four pawing actions in the air with their front legs before the eagle began its first stoop. The entire herd then swung around and ran in a close group. The first two stoops of the eagle were unsuccessful in that it was not able to catch and hold onto an animal. After each dive it rose into the air about 40 feet (12 m) and flew after the running herd until it was again above the last members. On the third stoop the bird's talons caught a female fawn squarely on the back. The bird was able to hold on to this fawn for about a minute before it was dislodged by the running and jumping of the fawn. At 12:58 the eagle made a fifth dive on the herd which was still running, and managed to clutch a second fawn female. This fawn was held in the same manner as the first. The eagle rode facing at right angles to the length of the prey and dug its talons into the lumbar vertebrae region. By spreading its wings it was able to maintain its balance and peck at the dorsal region of the pronghorn. The fawn's only defense was to try and buck the eagle off. It did not bite at the eagle or attempt to break its grip by rolling in the snow. By 13:03 the fawn was stumbling regularly and at 13:18 it was dead. At no time did the bird lose contact. At 13:34 a second eagle arrived at the carcass and fed on it while the first sat on a nearby fence post. The carcass was weighed on a Toledo scale after the birds had finished feeding on portions of the ribs, intestines and one hind quarter. It weighed 63 pounds (28.6 kg) and was estimated to have had a live weight of about 70 pounds (31.7 kg). These attacks were made in a 12-15 mph (19.3-24.1 kmph) wind, at −2°F. (−18.9°C) with 4.7-17.7 inches (12-45 cm) of crusted snow on the ground. The fawn was believed to have died of exhaustion and shock (the kill required 20 minutes). Lehti (1947) reported a similar kill of an 80 pound (36.3 kg) doe, which he believed to have been killed within 1.5 minutes, as a result of shock and a spinal cord injury.

The "bunching" response of pronghorns was pronounced when an eagle flew low over a herd. Buteos, a snowy owl and an airplane were also observed to elicit alarm in herds. The speed and complete participation of all herd members in forming a "bunch" indicates that this behavior pattern may be particularly effective in protecting individuals from avian attack. A similar response to other disturbances (humans, vehicles, and coyotes) was seen, but the herd did

not usually pack together so tightly and they were much more prone to run. On February 24th 59 pronghorns were located in a "bunch" with a golden eagle sitting on the ground approximately 150 yards (137 m) from them. This single bird kept the herd members "bunched" for at least 37 minutes before they began feeding and resting normally. On another occasion, the 21 members of a resting herd were able to detect an approaching golden eagle and form a "bunch" while the bird was still about a quarter of a mile (.4 km) away. This synchronized reaction of the herd is probably facilitated by the alarm cough (Van Wormer 1969) and/or the special body stances taken at such times (head and ears held high, rigid body). That entire herds quickly synchronize their alarm response to approaching raptors, but not to coyotes, may be because the birds are easier to locate, or because a special alarm signal is used for avian predators. Clearly, the differences in herd response to ground and avian predators in the cases observed were mainly of intensity of "bunching", either while standing or fleeing.

Two points emerge from an analysis of these observations; firstly, that predation by both types of predators may not be selective to old or injured prey, and secondly, that sufficient predatory pressure has been applied by golden eagles to develop specific alarm and escape patterns in pronghorns.

Literature Cited

Bruns, E. H. 1969. A preliminary study of behavioral adaptations of wintering Pronghorn Antelopes. M.Sc. Thesis. University of Calgary. 60 pp.

Buechner, H. K. 1950. Life history, ecology, and range use of the pronghorn antelope in Trans-Pecos Texas. Am. Midl. Nat. 43(2): 257-354.

Einarsen, A. S. 1948. The pronghorn antelope. The Wildl. Mgmt. Inst. Washington, D.C.

Lehti, R. A. 1947. The golden eagle attacking antelope. J. Wildl. Mgmt. 11: 348-349.

Murie, A. Ecology of the coyote in the Yellowstone. U.S. Printing Off. Washington, D.C. Fauna of Nat. Parks Bull. No. 4, 206 pp.

Rand, A. L. 1947. The 1945 status of the pronghorn antelope, *Antilocapra americana* (Ord) in Canada. Natl. Mus. of Can. Bull. 106, 34 pp.

Schaller, G. B. Hunting behaviour of the cheetah in the Serengeti National Park, Tanzania. E. Afr. Wildl. J. 6: 95-100.

Van Wormer, J. 1969. The world of the pronghorn. J. B. Lippincott Co., Philadelphia and New York, 191 pp.

Received October 29, 1969
Accepted April 19, 1970

Notes

A Simple Device for Measuring Eggshell Thickness

Abstract. A direct reading dial thickness micrometer with parallel anvils was modified by the addition of a device consisting of a ball bearing mounted on a brass cap which was then fitted over the lower anvil thus enabling the thickness of a curved object to be measured to the nearest 0.01 mm.

While conducting research on the effects of pesticide residues on eggshell structure it was apparent that conventional calipers were unsuitable for making thickness measurements. These instruments either have parallel jaws, which can not be used to determine the thickness of a curved plane, or points which were found to be widely inaccurate due to either poor alignment or point flexibility which varied according to the pressure applied.

To overcome these difficulties a direct reading dial thickness micrometer as seen in Fig. 1 (available: Mercer Ltd., Eywood Rd., St. Albans, Hertfordshire, England; or Allied Tools Ltd., 7219-104 Street, Edmonton, Alberta) was used. This micrometer is constructed with a spring loaded upper anvil which moves towards the fixed lower one and in addition has a movable dial face. To this micrometer a simple device was added which was constructed of a ball bearing of approximately 6 mm. diameter which was soldered to a brass cap hollowed to fit on the lower anvil (Fig. 2). When this device was in place the dial was rest to zero and eggshells were easily measured to the nearest 0.01 mm.

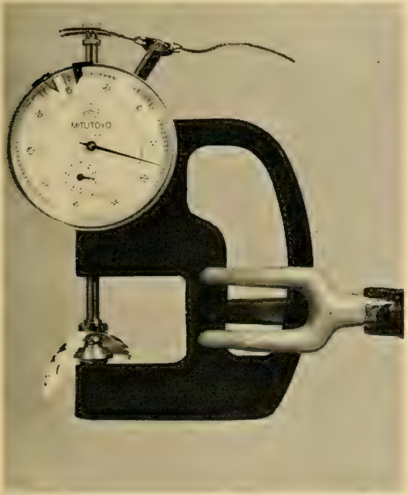


FIGURE 1. Dial thickness micrometer with accessory device in place on lower anvil.

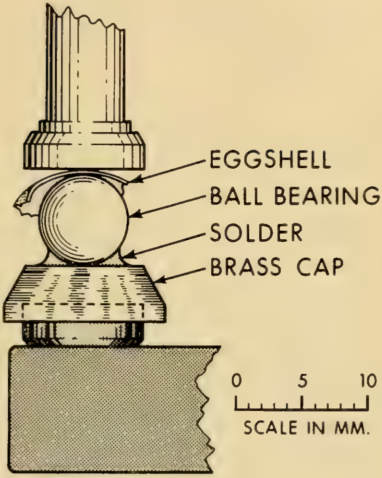


FIGURE 2. Detail of accessory device which converts micrometer from parallel anvil type to tangent sphere type so that the thickness of curved objects can be measured.

VICTOR LEWIN

Department of Zoology
University of Alberta
Edmonton, Alberta
Received September 1, 1970
Accepted September 8, 1970

Some Breeding Records for Birds on the Central Coppermine River

Abstract. Breeding records for 10 species of birds, including a 250 mile range extension for the Blue-winged Teal, and some general faunal observations are given for a biologically unexplored area on the central Coppermine River.

From July 27 through August 2, 1969, I was with a party of fishermen at a private camp maintained by Maxwell W. Ward of Edmonton on Redrock Lake on the Coppermine River at about 65° 29′ N, 114° 24′ W. We travelled a distance of 33 miles on the Coppermine River from where it leaves Point Lake to the first big rapids below Rocknest Lake. The entire area is on, or just inside, the tree line in the forest-tundra section of the northern boreal forest defined by Rowe (1959). The area has had no systematic zoological investigation since Richardson first viewed it during the first Franklin expedition in 1821 (Franklin, 1823). Therefore it seems worthwhile to record my limited observations. Nomenclature of Hall and Kelson (1959) for mammals, Godfrey (1966) for birds, and Slastenenko (1958) for fish is used.

Fishing was predictably excellent. The catch consisted of many lake trout (*Cristivomer namaycush*) and arctic grayling (*Thymallus arcticus signifer*), and a few large northern pike (*Esox lucius*). Except for Parry's ground squirrel (*Spermophilus undulatus parryii*), mammals were not abundant. We saw two wolves (probably *Canis lupus mackenzii*) scavenging in the camp, a barren-ground grizzly (*Ursus richardsoni*) and tracks, scats and digging of others, and a solitary bull barren-ground caribou (*Rangifer tarandus arcticus*).

The presence of young birds, not yet flying, or not flying strongly enough to have travelled any appreciable distance, showed that the following birds breed in the area. Redrock Lake still had much ice well into July, and the nesting season appears to have been late in the north.

BLUE-WINGED TEAL, *Anas discors*.

A female and three downy young were seen at a rapid on the north side of Redrock Lake about 65° 30′ N, 114° 09′ W. This extends the breeding range given by Godfrey (1966) by nearly 250 miles.

COMMON GOLDENEYE, *Bucephala clangula*.

A female with four black and white downy young, seen on Rocknest Lake, August 1, were most likely of this species, judging from distribution maps, and general size and appearance of the adult.

GYRFALCON, *Falco rusticolus*.

A nest with two young, just ready to fly, was seen on a south-facing cliff on Redrock Lake. A nearby abandoned nest contained four whitish eggs, and beneath it were remains of ground squirrel and ptarmigan. It may have belonged to a Rough-legged Hawk (*Buteo lagopus*) driven off, or killed earlier in the season by falcons. In 1968 the same cliff held only a Peregrine Falcon (*F. peregrinus*) nest according to Kim Ward who showed me the site.

WILLOW PTARMIGAN, *Lagopus lagopus*.

Willow Ptarmigan, with young not yet flying, were seen at the western and eastern extremities of Redrock Lake.

SEMIPALMATED PLOVER, *Charadrius semipalmatus*.

Downy young plover were seen near the fishing camp, and, from the actions of parent birds, were probably in a number of other places as well.

LESSER YELLOWLEGS, *Totanus flavipes*.

Yellowlegs attending flightless young were noted twice on central and western Redrock Lake. According to Godfrey, this is the margin of this species' breeding range.

AMERICAN ROBIN, *Turdus migratorius*.

Flying young robins were seen once, and adults were seen and heard singing at the fishing camp.

TREE SPARROW, *Spizella arborea*.

Several pairs were seen feeding flying young near the fishing camp.

HARRIS'S SPARROW, *Zonotrichia querula*.

This bird is common to hillsides having much arctic birch (*Betula glandulosa*). Adults were twice seen feeding flying young.

WHITE-CROWNED SPARROW, *Z. leucophrys*.

A pair was seen feeding flying young at the fishing camp, and a number of adults and flying young were commonly seen elsewhere.

In addition, I saw Yellow-billed Loon (*Gavia adamsii*), Pintail (*Anas acuta*), Red-breasted

Merganser (*Merganser serrator*), Golden Eagle (*Aquila chrysaetos*), Spotted Sandpiper (*Actitis macularia*), Least Sandpiper (*Erolia minutilla*), Semipalmated Sandpiper (*Ereunetes pusillus*), Parasitic Jaeger (*Stercorarius parasiticus*), Herring Gull (*Larus argentatus*), Bonaparte's Gull (*Larus philadelphia*), Arctic Tern (*Sterna paradisaea*), Gray Jay (*Perisoreus canadensis*), Raven (*Corvus corax*), Gray-cheeked Thrush (*Hylocichla minima*), Water Pipit (*Anthus spinoletta*), and Savannah Sparrow (*Passerculus sandwichensis*). Most of these undoubtedly nest in the general area. The two gulls, in particular, included both adults and flying young of the year.

Literature Cited

Franklin, J. 1823. Narrative of a journey to the shores of the polar sea in the years 1819, 20, 21 and 22. (2 Vols.). London.

Godfrey, W. E. 1966. The birds of Canada. Nat. Museum of Canada. Bull. No. 203, Biol. Series No. 73.

Hall, E. R. and **K. R. Kelson.** 1959. The mammals of North America (Vol. 1 and 11). The Ronald Press. N.Y.

Rowe, J. S. 1959. Forest regions of Canada. Dept. of Northern Affairs and National Resources, Forestry Branch Bull. 123.

Slastenenko, E. P. 1958. The freshwater fishes of of Canada. Kiev Printers, Toronto.

JOHN P. KELSALL

Canadian Wildlife Service,
10015 - 103 Avenue,
Edmonton, Alberta

Received October 3, 1969
Accepted March 13, 1970

Unusual Flight Behavior of Whooping Cranes in Saskatchewan

Abstract. On 11 May 1969, a flock of seven Whooping Cranes was observed on the south shore of Montreal Lake, Saskatchewan, flying with their feet drawn forward under their bellies. This unusual form of flight behavior has been observed by others in Sandhill Cranes, which some have tentatively attributed to being a reaction to cold weather. It is suggested here that cold weather was probably the cause of such behavior in Whooping Cranes as well.

On 11 May 1969, at approximately 8:30 a.m., a flock of seven Whooping Cranes, *Grus americana*, was observed by 4 people, Alvin Schellenberg, Edd Banman, Irvin Dyck, and me, on the south shore of Montreal Lake. The location was about ½ mile or slightly more to the northwest of the main beach which lies at the southern tip of the lake, about 18 miles by road to the northeast of Waskesiu, Prince Albert National Park. The flock came almost directly from the southeast, and flew in a lopsided, poorly formed V. The height of the flock from the ground was about 150 feet or a little more. The birds constantly emitted very loud whooping calls until they could no longer be heard soon after their disappearance over the trees beyond the lake. In fact, it was their calls which first attracted our attention, as we heard them for a minute or so before the birds themselves appeared over the tops of the trees directly to the south and east of the shore and just a few feet from where we stood.

A very noticeable peculiarity of the cranes was that they did not fly with their legs stretched out as I have observed Whooping Cranes doing on a previous occasion (in 1960). Observations reported in Bent (1926) indicate that flying with the legs stretched out behind is the normal behavior for Whooping Cranes, and Allen (1952) also holds this point of view, writing that when Whooping Cranes are in flight their "long black legs stretch out behind." According to Bard and Lahrman (1965) this would appear to be the normal manner of holding the legs in flight for Sandhill Cranes as well.

All seven of the Whooping Cranes observed flew in the unusual manner mentioned with their legs held forward in what appeared to be a doubled-up position underneath their bodies. This was evidenced by the long dark patch on the abdomen of each bird which first attracted my attention to the peculiarity. Regardless of this peculiarity, however, there could be no mistaking the identity of the birds; their general white coloration, the long necks, the dark patches on their heads and wings, and their calls made very clear their identity.

Bard and Lahrman (1965) noticed a similar form of behavior among Sandhill Cranes near Last Mountain Lake, Saskatchewan, on 31 April 1961. They state that the birds "flew with their feet drawn forward and tucked into the belly plumage.

On two occasions we saw such birds suddenly straighten their legs out, assuming their usual appearance." At no time during the few minutes that I observed the Whooping Cranes did they straighten out their legs.

I have been able to locate only one other report on similar flight behavior in Sandhill Cranes and none at all for Whooping Cranes. Walkinshaw (1953) states that during the morning of 28 March 1948, in Indiana, he saw 405 Sandhill Cranes come from a roosting area, and each one, with the exception of only a very few, carried its "legs drawn in under the body, not trailing as is usually the case." The temperature at 6:00 a.m. that day was 17° F, and a snowstorm the previous night had covered the ground with several inches of snow. He makes no conclusions about the possibility of this unusual flight behavior being a direct response to cold weather, but simply states that this is the manner in which they flew during the period of low temperature that morning. Bard and Lahrman (1965) do, however, tentatively suggest that this form of behavior among Sandhill Cranes is a direct response to cold weather, and the reason they give for this conclusion is that the day during which they made their observation was so cold that the water at a spring was frozen. They state that Canada Geese have also been observed flying in a similar manner, with their feet tucked forward under their bellies, during very cold weather.

Whether or not the Whooping Cranes flew with their legs tucked forward because of cold weather remains open to speculation. I would guess, however, that cold weather actually was the reason, since there had been a rather sharp frost earlier during the morning of my observation, and the air was still very chilly when the birds flew over the lake, although the frost had disappeared about an hour before then. Since observations on similar behavior in other species of large birds with much exposed leg surface were also made during cold, frosty mornings, it would seem that this form of behavior in Whooping Cranes can be attributed to the same cause with reasonable certainty.

The above-mentioned observation made by myself recalled to my mind another on the more usual form of flight behavior of Whooping Cranes also made by myself, but some years earlier, in 1960. This observation was made on 8 May 1960, at approximately 10:00 a.m., about 5 miles west and 1 mile south of Hanley, Saskatchewan, less than ½ mile west of Brightwater Creek (now Brightwater Lake, due to a recent dam). The countryside was a flat, treeless plain, except for the creek valley.

A total of 14 birds in 2 separate flocks was seen on this occasion, one flock consisting of 9 individuals and the other of 5. They flew about 150 to 200 feet from the ground, and occasionally one would emit a long-drawn call with a rolling vibration which bore a considerable resemblance to the call of the Sandhill Crane, with more vibration and less of the whooping sound in the call than had the calls of the birds heard this year at Montreal Lake. The flocks came from the east, but changed direction overhead to the southwest, in which direction lie a number of fairly large sloughs. In this case the legs of the cranes were stretched out behind them in what would seem to be the more normal manner of flight for cranes.

Literature Cited

Allen, R. P. 1952. The Whooping Crane. National Audubon Society, Research Report No. 3, New York.

Bard, F. G., and F. W. Lahrman. 1965. Sandhill Cranes flying with feet drawn up. Blue Jay 23: 121.

Bent, A. C. 1926. Life histories of North American marsh birds. Smithsonian Institution United States National Museum Bulletin 135. (Dover reprint, 1963.)

Walkinshaw, L. H. 1953. Notes on the Greater Sandhill Crane (*Grus canadensis tabida*). Auk 70: 204-205.

HENRY T. EPP

Department of Anthropology
and Archaeology,
University of Saskatchewan,
Saskatoon, Sask.
Received September 12, 1969
Accepted March 19, 1970

Some Observations on the Nesting of The Western Painted Turtle, *Chrysemys Picta Belli*, in Northern Minnesota

Abstract. The mean clutch size of the Western Painted Turtle, *Chrysemys picta belli*, in northern Minnesota was found to be 11.9 eggs (9-19). Factors

observed to adversely affect the success of the eggs were predation and desiccation.

From June 9 to July 14, 1967 female western painted turtles. *Chrysemys picta belli*, were observed nesting in the Maple Lake area, Polk County, Minnesota. Many of the numerous sloughs, ponds and small lakes in the area harbored large numbers of *C. p. belli*. The sites most commonly used by the females for nesting were garden beds next to farmhouses, cultivated fields and the shoulders of dirt roads.

The mean clutch size for ten nests was 11.9 eggs (9-19). The mean length of 119 eggs was 30.1 mm (27.4-4-36.1) and the mean width was 18.5 mm (17.0-20.0). Carl (1944) reported a maximum single clutch size of 20 for *C. p. belli* in British Columbia. On one occasion a female was found that contained 18 oviducal eggs. The next highest number of eggs found in the nests was 14. For *C. p. belli* in southern Minnesota, Legler (1954) has reported a mean clutch size of 8.8 eggs (5-11) for 13 nests. The difference between the mean number of eggs per nest for *C. p. belli* from northern and southern Minnesota is significant ($p < 0.05$). Larger clutch sizes for northern turtle populations have been reported by Powell (1967) for *Chrysemys picta* in Nova Scotia and by Tinkle (1961) for *Sternothaerus odoratus*. It is doubtful that *C. p. belli* in northern Minnesota lay more than one clutch per year.

The often reported problem of nest predation was observed to be extremely heavy for those nests located along the shoulders of the dirt roads. However, the nests located in the one cultivated field where observations were made escaped this hazard.

Desiccation is probably the next most serious problem facing a developing turtle egg. This problem was noted on August 9, 1967 when a nest located in a cultivated field was opened and found to have three of its nine eggs dried up. This was probably the result of the low moisture content of the sandy soil in this field coupled with nest temperatures which reached a maximum of 94°F in this nest between June 14 to July 22, 1967. The growth of the barley crop in this field in late July might have reduced soil evaporation losses and provided a cooler microclimate for the nests during the daylight hours. Additional desiccation losses may have, therefore, been prevented.

The common practice in this area of grading the dirt roads also appears to have an important effect on the micro-climate of the turtle nests since the usual result of this practice was a removal of some of the soil which provided insulation for the nests. One nest was found where the soil covering the top of the nest had been completely removed thus exposing the uppermost egg in the nest. Conceivably, this practice influences both the incubation period and the desiccation rate of the eggs.

Acknowledgments

I wish to thank Dr. M. Max Hensley and Dr. J. R. Reilly for reviewing this manuscript.

Literature Cited

Carl, C. 1944. The reptiles of British Columbia. British Columbia Provincial Museum Handbook 3: 5-60.

Legler, J. M. 1954. Nesting habit of the western painted turtle, *Chrysemys picta bellii* (Gray). Herpetologica 10: 137-144.

Powell, C. B. 1967. Female sexual cycles of *Chrysemys picta* and *Clemmys insculpta* in Nova Scotia. The Canadian Field-Naturalist 81: 134-140.

Tinkle, D. W. 1961. Geographic variation in reproduction, size, sex ratio and maturity of *Sternothaerus odoratus* (Testudinata: Chelydridae). Ecology 42: 68-76.

D. J. GEMMELL

Department of Zoology
Michigan State University,
East Lansing, Michigan 48823
Received April 8, 1969
Accepted January 25, 1970

A New Northern Record for the Eastern Kingbird

Abstract. An Eastern Kingbird was collected on Leyson Point, Southhampton Island, Northwest Territories on July 2, 1967, National Museum Collection No. NMC-56, 137.

On July 2, 1967, I found an adult Eastern Kingbird (*Tyrannus tyrannus* L.) on the southeast

coast of Leyson Point, Southampton Island. A specimen found dead in August 1954 by A. G. Loughrey on Bencas Island, about 40 miles to the south, was the previous northernmost record for eastern Canada (Snyder, L. L. 1967. Arctic birds of Canada. University of Toronto Press, Toronto. 310 pp.). A specimen was collected farther north in western Canada at Bathurst Inlet in June 1953 (Kelsall, J. P. 1966. Additional bird observations at Bathurst Inlet, N.W.T. Canadian Field-Naturalist 80(3):178-179); and an adult, one of four observed, was collected at Norman Wells on August 2, 1958 (Godfrey, W. E. 1965. Range extensions of some birds in western Mackenzie. Canadian Field-Naturalist 79(1):34-38).

The specimen collected on Southampton Island first appeared at a camp on Leyson Point on June 10, 1967, during a late spring storm from the south. An Eskimo had observed the Kingbird incapable of flight and huddled against the ground flaps of his tent. After examining the bird, he threw it into a nearby pit where it died.

During this same storm I was on Coats Island, 40 miles to the south, and observed large flights of shorebirds arriving in the area and feeding in the kelp beds which had been washed ashore the previous autumn. The high ground of both islands and most of Evans Strait were still completely ice and snow covered on June 10, though the temperature was generally above freezing throughout the day. When I arrived at the Leyson Point camp on July 2, the ground was mostly free of snow, but the earth was still frozen.

The Kingbird had decomposed only slightly when I found it in the pit, and was readily remembered by the Eskimo. I tentatively classed it as a male, though internal decomposition precluded positive determination of the sex. Identification was confirmed by Mr. W. Earl Godfrey, Head Vertebrate Zoologist, National Museum of Canada, and the skin of the specimen was placed in the National Museum collection, NMC-56,137.

CHARLES J. JONKEL

Canadian Wildlife Service,
293 Albert Street,
Ottawa 4, Ontario.
Received August 15, 1969
Accepted October 15, 1969

The Sabine's Gull in Southwestern British Columbia

Abstract. Records of the Sabine's Gull, *Xema sabini*, in south-western British Columbia have been gathered from various sources for the period 1963 through 1969. In fall migration the gull is a rare transient in the Victoria area and farther inland, at Vancouver, a casual transient. Only occasionally is the bird a winter visitant to Victoria. Brief comments on foods and plumage are given.

In littoral waters along the British Columbia coast the Sabine's Gull, *Xema sabini*, is a regular fall transient (Munro and Cowan, 1947, Westerborg, 1964 and pers. obs. — 500 gulls estimated ten to fourteen miles off Tofino, Vancouver Island on September 13, 1969) being less common in spring here. In inside waters, that is Juan de Fuca Strait and the Strait of Georgia, its distribution and status are poorly known. During the past seven years many naturalists in south-western British Columbia, especially Victoria and Vancouver, have recorded and in some instances published their sightings of this gull in their respective journals, namely The Victoria Naturalist and the Vancouver Natural History Society Bulletin. The sightings which follow include records from these publications as well as unpublished notes obtained from naturalists in the southwestern part of the Province.

Some of the earliest records for the Sabine's Gull in inside waters are furnished by Munro and Cowan (1947). Mention is made of birds collected at Sooke, Vancouver Island on October 11, 1920 and October 20, 1963. Recent records, a little farther inland, in the Victoria area (mainly Clover Point) are as follows: September 27, 1963 — 1 (D. Stirling and R. Y. Edwards); October 24, 1963 — 5 (G. A. Poynter); December 21, 1963 — 1 (Christmas Count); August 25, 1966 — 1 (G. A. Poynter and J. Tatum); November 25, 1966 — 6 (R. Fryer); December 7, 1966 — 4 (R. Fryer); October 21, 1967 — 1 immature (G. deCamp and G. A. Poynter); December 10, 1967 — 1 adult and 1 immature (G. A. Poynter); September 7, 1968 — 2 (R. Fryer); October 20, 1968 — 1 immature (R. Fryer and G. M. Bell); December 3, 1968 — 3 (R. Fryer and October 8, 1969 — 1 (G. A. Poynter).

Between the two cities of Vancouver and Victoria, in Active Pass, Edwards (1964) mentions seeing a Sabine Gull on September 27, 1963. Dr. K. C. Boyce (pers. comm.) reports seeing two

Sabine's Gulls at Point Roberts, just south of the International Boundary, on November 9, and 10, 1963.

Vancouver records are few. The earliest record I can locate is that supplied by M. Schouten (pers. corr.). She recorded a Sabine Gull off the Iona Island jetty in Vancouver on October 20, 1967. The writer saw this same bird, an immature, on October 27 as did W. Weber two days later. Ian R. McGregor (pers. corr.) recorded a Sabine Gull, in adult plumage, at the Campbell Avenue fish docks in Vancouver on October 31, 1967. Two Sabine's Gulls, then, an immature and an adult, were in the Vancouver area in October, 1967.

Two years later, on September 8, 1969, an immature Sabine Gull was spotted by the writer on the lawn of Minoru Park in Richmond (just to the south of Vancouver). K. Kennedy and the writer observed the gull feeding on earthworms, picked up from the damp grass and cement parking lot at a nearby fire station. The following day T. Stevens and the writer watched the gull for some time. On this visit the gull was observed chasing, catching, and eating marsh crane flies, *Tipula paludosa Meig.*, which were very abundant. By the time we left the gull had gorged itself on these insects. It was approachable to within six feet and several color and black and white photographs were taken "for the record". The gull remained in this area until September 14. It was solitary in its habits seldom associating with Mew Gulls, *Larus canus*, Ring-billed Gulls, *Larus delawarensis*, California Gulls, *Larus californicus*, and Glaucous-winged Gulls, *Larus glaucescens*, which also were feeding and resting in the park.

The only record I can find for spring migration on inside waters is a sighting by R. Fryer at Clover Point, Victoria, on April 15, 1969.

In North America the Sabine Gull breeds on the coasts and islands of arctic Canada and migrates mainly along the Pacific Coast (Godfrey 1966). In fall migration the gull has been reported at Queen Charlotte Sound on August 1 and at Pine Island, northern tip of Vancouver Island, on August 16 (Munro and Cowan 1947). Campbell and Stirling (1968) report seeing a Sabine Gull in breeding plumage near Cleland Island off the central West Coast of Vancouver Island on August 25. The earliest fall migration date for inside waters at Victoria is also August 25 while the earliest fall date for Vancouver is September 8. Although the Sabine Gull may show up in southwestern British Columbia as early as late August most records are in late October, November and December, probably attributed to storms at sea.

From recent records it appears that the Sabine Gull is a rare transient in fall migration at Victoria and occasionally may be a winter visitant here. The gull becomes less common farther inland as in the Vancouver area where it is only a casual transient. There are no spring migration records for Vancouver and only one for Victoria.

According to Bent (1921) the adult winter plumage is assumed in August and September, the period for the complete postnuptial molt. The bird seen on August 25, 1968 off Cleland Island appeared in full breeding plumage as did gulls seen at sea off Tofino on September 13, 1969. Ian R. McGregor (pers. corr.) mentions also that the bird he saw in Vancouver on October 31, 1967 had a black head but the tail was slightly rounded which he attributed to a partial molt being in progress.

Acknowledgments

The author wishes to thank Dr. R. Drent for his criticisms in the first draft of this paper.

Literature Cited

Bent, A. C. 1921. Life Histories of North American Gulls and Terns. U.S. Nat. Mus. Bull. 113. Washington, D.C.

Campbell, R. W. and **D. Stirling.** 1968. Notes on the Natural History of Cleland, British Columbia, with emphasis on the Breeding Fauna. B.C. Prov. Mus. Report, 1967: 25-43, figs. 1-11.

Edwards, R. Y. 1964. Birds Seen in Active Pass, British Columbia. B.C. Prov. Mus. Report, 1964: 19-23.

Godfrey, W. E. 1966. The Birds of Canada. Nat. Mus. of Can. Bull. 203, Ottawa.

Munro, J. A. and **I. McT. Cowan.** 1947. A Review of the Bird Fauna of British Columbia. B.C. Prov. Mus. Spec. Publ. 2: 1-285, figs. 1-42. Victoria.

Westerborg, B. 1964. Sea Birds off Tofino. Victoria Nat., 21: 27-28.

R. WAYNE CAMPBELL

301 - 621 Gilbert Road,
Richmond, B.C.
Received November 20, 1969
Accepted March 25, 1970

Letters

Observations on the Decline and Survival of the Peregrine Falcon

Probably all Peregrine Falcon (*Falco peregrinus*) populations in North America are endangered, by pesticides, although in the Queen Charlotte Islands of B.C., southern Alaska, and parts of the boreal and tundra regions of the arctic, numbers are still relatively high. Unfortunately, several overly simplified statements have appeared in this Journal in recent months which only obscure the serious questions which must be resolved if the species is to be saved from total extinction on this continent. I would like to indicate some of those aspects of the biology of the Peregrine that have to be borne in mind when we are considering how this species may be helped to survive. I would also like to discuss some of the problems and some more hopeful aspects concerning the Peregrine.

1. *A Non-breeding Surplus of Adult Falcons*

It has been suggested by Hickey (1942) and Cade (1968) that the reason that a lost member of a pair (e.g. shot at nest cliffs) was so quickly replaced in years gone by was that there was a non-breeding surplus of adult falcons. Cade (1968: 239) states:

> "Evidently the falcon populations long ago evolved a social organization that strongly buffers the breeding pairs against numerical reduction, through the production of a large reservoir of sexually competent non-breeders, able to replace losses in the breeding population rapidly."

Therefore, it would appear that when we see an actual decline in the number of nesting pairs, the *surplus* (an unknown percentage of the population) may *already* have been exhausted. Those birds that continue to survive once the decline is underway are probably the ones with summering and wintering areas, migration routes, and perhaps even individual food habits, that have somehow until then spared them from accumulating lethal doses of biocides. Or, alternatively, the surviving falcons' parents were somehow not yet stricken with the sublethal biocide levels which yield thin eggshells and greatly reduced reproduction.

Adult female Peregrine Cacking from the nest ledge just before leaving to attack a passing Bald Eagle.

2. *Falcon Mortality*

Various students of falcons (Hickey, 1942; Beebe, 1960; Cade, 1960; and others) have suggested that a high proportion of young falcons die in their first winter, from starvation through inexperience, disease, becoming lost at sea, etc. Henny and Wight (1969) and Enderson (1969) have calculated from banding returns, for Osprey and Peregrines respectively, that over half of the birds hatched do not live to be one year old. Beyond the age of one year, only approximately one-fifth of those remaining die each year. Peregrines may survive to at least 20 years of age in the wild, and pairs have been known to remain intact for as long as 14 years (Herbert and Herbert, 1965)! All this suggests that once the falcons have survived their first fall and winter, they seem to have a reasonably high life expectancy.

3. *Some Peregrine Populations and Decline Potentials*

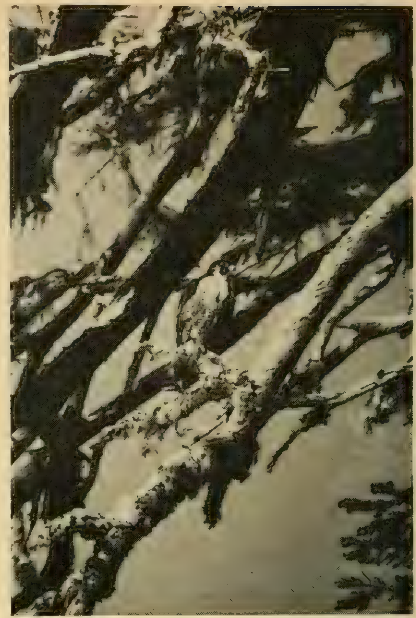
The portion of the letter from the Cornell Birds of Prey Conference to various government agencies that was quoted by Mosquin (1969) stated that "Even some remote arctic Canadian populations have declined recently." Both the paper by Cade, White and Haugh (1968) and the paper by Enderson and Berger (1968) have warned of a probable population crash due to high pesticide residue levels in arctic Peregrines. Indeed, some abnormalities were noted during 1969 surveys, and in some areas a decline in breeding numbers was detected (R. W. Fyfe, pers. comm.). Perhaps the decline in the arctic is now underway, in a manner that we can now actually see (e.g. deserted nest sites).

Peregrine populations on the Queen Charlotte Islands appear to have been stable to date, with the exception of that on Langara Island (Blood, 1968, 1969). On Langara Island a complex of factors has been at work, and the data presently available are insufficient to allow anyone to assign with any certainty the correct degrees of relative blame to the several possible causes of the decline there (studies in progress). The decline in numbers of Peregrines on Langara Island apparently started in 1958 (see Beebe, 1960: Table 2 — five of twelve eyries unoccupied), but it appears to have been atypical, since the B.C. Fish and Wildlife Branch surveys have shown no detectable decline in population through 1968 for other parts of the islands (Blood, 1968, 1969). However, the Queen Charlotte Island Peregrines do contain quite appreciable levels of pesticide residues (study in progress). There is a healthier population on Amchitka Island in the Aleutians (C. M. White, pers. comm.), and presumably this could be expected also for the rest of the Aleutian Island chain.

It would, then, appear that some parts of the arctic populations are starting to decline visibly. But, though the Peregrines of the B.C. coast have shown no certain widespread decline as yet, they are no longer uncontaminated by pesticides. The Aleutian Islands Peregrines may be presently spared the effects of pesticides. Aside from these populations, most of the remainder of the North American populations have collapsed (see Hickey, 1969).

4. *Harvesting of Falcons*

Mosquin (1969) quoted from a government press release concerning the harvest of Peregrines



Male on guard near the nest ledge.

from the Queen Charlotte Islands in 1969. The falcon nestlings were removed by B.C. Fish and Wildlife Branch biologists from an area that is fairly well known as far as its falcon population is concerned (D. A. Blood, pers. comm.), and this study is probably the first of its kind anywhere attempting, as the press release tells us, "to provide information on the effects of a *known removal rate on long-term population trends* . . ." (Italics mine.)

The very substantial rate of harvesting of Gyrfalcons (*Falco rusticolus*) in Iceland in the 17th and 18th centuries has been assessed by Cade (1968) in the following terms:

> ". . . it appears likely that human depredations alone removed something on the order of 25 to 50 per cent — or more — of the annual production of fledged young. Yet there is no evidence that this degree of molestation had any depressing effect on the breeding population over several centuries."


Adult male about to settle onto eggs. Earlier in incubation this nest contained three eggs; one egg disappeared mysteriously.

But Cade also cautions that:

> "At the present time we do not know for a single species of falcon or hawk what the safe level of harvest is."

The *controlled* harvesting of nestling falcons by the B.C. Fish and Wildlife Branch could, if continued, constitute an important study.

Because of the apparently high mortality rate of immature falcons, there may be some justification for harvesting nestlings, some of which (particularly the smallest ones) might otherwise not survive through the fall and winter. In order to allow the parent falcons to complete the breeding cycle, at least one nestling must, however, be left in each eyrie. At the same time, removal of one or more nestlings may result in a better supply of food for those left behind. Certainly the harvesting of nestlings for these reasons and in this manner is greatly to be preferred to the trapping of adult falcons (haggards) which have proved their ability to survive.

5. *Falconry and Some Relationships to Birds of Prey*

It is quite possible that an overharvest by falconers has occurred (quite legally) in some areas. This simply points out the need for more research and better management of these species.

Were it not for the activities and research of a number of falconers, much of the information that we now have on raptor populations and their declines would not be known. Much of the scientific literature on the birds of prey has been contributed by falconers and by people who became interested in these birds through falconry. While it would be untruthful to claim that all falconers cared more about the birds in the wild than their own enjoyment of this difficult ancient art, it *is* accurate to state that many falconers have done, and are doing, a very great deal to ensure that the birds of prey survive.

6. *Captive Breeding of Peregrines*

Since Peregrines on this continent may vanish totally from the wild, it is prudent to attempt to breed them in captivity while there are still some birds in existence. Not surprisingly, it has been falconers who have made almost all the attempts at captive breeding of falcons to date. A number of falconers are spending considerable amounts of money and time trying to devise positive methods

of breeding falcons. Because of space and financial requirements, it has been difficult for any number of pairs to be set up in one location, so the various pairs of falcons have been cared for by private individuals. Furthermore, few non-falconers have the knowledge required to keep falcons (especially the larger ones) in good health, or the devotion to the birds necessary to acquire them, care for them, and provide food and space for them.

Breeding of Peregrines in captivity *has* yielded some successes. Waller (1962, 1968) had captive Peregrines which raised nestlings in two different years during World War II. Beebe (1967) has obtained fertile eggs, and Larry Schramm of Portland, Oregon, successfully bred Peregrines in 1968 (Peterson, 1968) and is reported to have been successful again in 1969. At least a few others also have been successful in the last two seasons. The Patuxent Wildlife Research Center of the U.S. Bureau of Sport Fisheries and Wildlife has also begun some work with Peregrines (R. D. Porter, pers. comm.). Kendall (1968) has successfully bred Prairie Falcons (*Falco mexicanus*), and several people have succeeded with American Kestrels (*Falco sparverius*), the most notable instance being the large scale program at Patuxent (Porter and Wiemeyer, 1969, 1970).

With Peregrines it is a difficult task, as evidenced by the the limited number of successes to date. We must hope that some common factors can be discerned among successes, and some other factors among the failures, so that in future, successful breeding can become more assured.

A number of those attempting to breed falcons in captivity are less concerned with the possibility of using the offspring in falconry, and more concerned with the prospects of reintroduction of these birds to their original habitats — assuming that our environment will eventually be cleansed of pesticides. Whatever the motives of those trying to breed falcons in captivity may be, it is probably with them that the survival of the Peregrine is most certain.

The Peregrine Symposium sponsored by the North American Falconers' Association last November in Colorado expressed the view that some private efforts at breeding must be allowed to continue, but that other facilities should be also set up to help create a "self-sustaining captive Peregrine Falcon population", as with the Wildfowl Trust's project with the Nene (*Branta sandwichensis*) in England and the efforts with captive Whooping Cranes (*Grus americana*) in the U.S.A.

It is noteworthy that *none* of the Peregrines harvested in 1969 in B.C. were destined for government captive breeding projects in either Canada or the U.S.A. (the B.C. government, itself, is not yet engaged in a breeding project)! Consequently, little long-term control is being exercised over individual birds after they have been removed from the wild.

It is unfortunate that our governments are so oriented toward the shootable species of wildlife that they have, with only a few exceptions, little time, money or effort to expend on other more endangered and equally valuable species. Perhaps we should be turning to the consciences of corporate industry to foot the bill for research on the species of which the industries have caused the great declines.

In North America, Peregrines are divisible into three subspecies — the northwest coast *pealei*, the arctic tundra *tundrius* (see White, 1968), and the more continental *anatum*. The last of these, *anatum*, may already be too depleted to ever recover in the wild, so it is to *anatum* that the most urgent, and careful, action must be directed. But the actual perfection of captive breeding techniques will probably be achieved by those working with *pealei* and *tundrius*.

7. *Research and Human Disturbance*

Dekker (1969 a & b) has cautioned against the visiting of eyries by researchers. My own observations suggest that there is a short period prior to and during egg-laying when desertion of a nest ledge can be caused even by careful visits by man (Nelson, in press), although the falcons will lay again at another ledge. But, after this time, desertion in Peregrines seems to be rarely caused by non-destructive visits by research workers. Almost all of the studies that have illuminated the effects of pesticides have been conducted by visiting eyries (Ratcliffe, 1958, 1965, 1967; Cade, White and Haugh, 1968; Enderson, Roseneau and Swartz, 1968; Enderson and Berger, 1970; and others), and very few, if any, harmful effects of the visits to eyries have been detected by these researchers. Of course these people are aware of the possible damage that could be done by causing eggs or nestlings to be chilled or over-heated. The successful nesting of Peregrines in several large cities (Hall, 1955), and the apparent lack of harmful effects of recent research studies, suggest that Peregrines *do* seem capable of tolerating man's *careful* intrusions.

Ratcliffe (*in* Hickey, 1969: 247) has summarized the effects of the less careful intrusions into the Peregrine's life in Britain:

> ". . . the majority of permanent territory desertions due to human disturbance had taken place by about 1860, and that by 1900, the populations had reached a fairly stable level. Since then, more adequate records have established that between 1900 and 1939, the peregrine population in many parts of the British Isles remained almost constant."

And Cade (1968) has concluded:

> "Down through the centuries, not all the falcon trappers, egg collectors, war ministries concerned for their messenger pigeons, or misguided gunmen have been able to effect a significant reduction in the numbers of breeding falcons. But the simple laboratory trick of adding a few chlorine molecules to a hydrocarbon and the massive application of this unnatural class of chemicals to the environment can do what none of these other grosser, seemingly more harmful agents could do."

8. *Legislation and the Survival of Peregrines*

The portion of the letter from the Cornell Birds of Prey Conference quoted by Mosquin (1969) concluded with the words — "the taking of Peregrines for any purpose should be carefully regulated." Note that the word used is "regulated". The Cornell letter did not use the word "prohibit", or the words "total protection". A carefully regulated system would allow the taking of young for authorized breeding projects from reasonably stable populations, whereas *total protection* might well ensure total extinction for all North American Peregrines. For this reason the NAFA Peregrine Symposium in Colorado resolved that the conferees were in agreement with the placing of the North American Peregrine in the endangered species category, and "recommend *Federal regulation* pertaining to the taking of peregrines on the basis of regional populations." (My italics.)

The means are available of ensuring that falconry can continue without damaging the wild raptor populations, and that the actions of some falconers are not excessive. Some provinces and states have very satisfactory regulations, from both the viewpoint of non-falconers as well as that of falconers. However, the harvesting of any nestling Peregrines must be a carefully supervised undertaking, and it certainly is recognized that in *many* areas *no* harvesting of falcons could be justified. Most falconers are aware that any Peregrines they presently possess may have to be the last to come from the wild for some time, and that the obvious way to ensure the survival of these birds is to get them breeding in captivity. Indeed, many falconers have given up flying their Peregrines and are cooperating in breeding projects.

At the Colorado Peregrine Symposium, several resolutions were passed, which have since been ratified by the North American Falconers' Association. Clause IV of Resolution 4 ("A Plan for Regulating the Removal of North American Peregrines from the Wild") states that "All birds taken under permit and license would be identified by *lock-on* United States Fish and Wildlife Service bands. Birds already in captivity must be fitted with a band." (Italics mine.) This would mean that any Peregrine found in any person's possession and *not* carring a lock-on band would have been obtained illegally. This would seem to be the *one sure way of* reducing unnecessary (and unauthorized) taking of Peregrines from the wild. It is earnestly to be hoped that implementation of this procedure will rapidly be brought into operation in North America.

In considering the harvest of falcons for breeding projects in the future (and for falconry in the past) we are discussing a small factor in the overall decline, and one which is controllable, and from which a number of benefits can be derived.

What is most sad is that there is inadequate control of the use of persisting pesticides, and others potentially as dangerous, which have been the major contributing factor in the declines of Peregrine populations. As pointed out by Keith (1969), governments really must also insist on *thorough* testing of the long-term effects of new biocides *in advance* of application of them to the environment. Will it take another crash in raptor populations before we understand the future pesticides as well as we now understand DDT, 25 years after its use was started? The consciences of chemists and agriculturalists must not be allowed to continue to decide whether the world should be used as an experimental test tube for their products. It is *here* that the governments must also act — or act further.

Summary and Conclusions

That the Peregrine Falcon in North America is endangered cannot be denied. Because there is now no way of *ensuring* its survival in the wild, and because some successes have been achieved in the difficult task of breeding Peregrines in cap-

tivity, a self-sustaining captive population of these falcons may be the only means of perpetuating the species until such time as it would be safe to attempt to introduce them back into the wild.

More Peregrines might be taken into captivity at the nestling stage, in a carefully planned and regulated program, from those relatively large Pacific and arctic populations that have not yet demonstrated drastic declines in numbers, in order to discover and utilize the techniques necessary for reliable breeding of these falcons in captivity.

The start in this direction, with some successes, has been made by falconers. The devotion and knowledge of these people should be utilized to the fullest in future efforts to prolong the survival of Peregrines in the wild and in efforts to propagate the Peregrine in captivity.

Federal responsibility in the management of the Peregrine, and federal leadership in research on this and other such endangered species (with provincial and state assistance) is urgently needed. Governments must also act immediately in other fields as well, to ensure that such environmental degradation as has been caused by the chlorinated hydrocarbons is never again allowed to occur.

I can only conclude as have Hickey and Roelle (*in* Hickey, 1969):

"This decline continues, and the end is nowhere in sight."

Acknowledgments

I wish to thank Drs. T. J. Cade, J. H. Enderson, and M. T. Myres, and Messrs. D. A. Blood, R. W. Fyfe, and R. R. Olendorff for kindly reading an earlier draft of the MS and criticizing the accuracy of my remarks and observations. Dr. Myres assisted greatly in editing the paper. The conclusions I have expressed do not necessarily reflect the opinions of these people however.

Literature Cited

Beebe, F. L. 1960. The marine Peregrines of the northwest Pacific coast. Condor 62(3): 145-189.

Beebe, F. L. 1967. Experiments in the husbandry of the Peregrine. Raptor Research News 1(4): 61-86.

Blood, D. A. 1968. Population status of Peregrine Falcons in the Queen Charlotte Islands, British Columbia. Canadian Field-Naturalist 82(3): 169-176.

Blood, D. A. 1969. Peregrine Falcon surveys in coastal British Columbia. Biological Conservation 1(3): 250-251.

Cade, T. J. 1960. Ecology of the Peregrine and Gyrfalcon populations in Alaska. University of California Publications in Zoology, 63(3): 151-290.

Cade, T. J. 1968. The Gyrfalcon and falconry. Living Bird 7: 237-240.

Cade, T. J., C. M. White and **J. R. Haugh.** 1968. Peregrines and pesticides in Alaska. Condor 70(2): 170-178.

Dekker, D. 1969a. A plea for federal protection of the Peregrine Falcon. Canadian Field-Naturalist 83(1): 64-66.

Dekker, D. 1969b. A plea for federal protection of the Peregrine Falcon. II. Canadian Field-Naturalist 83(4): 410-411.

Enderson, J. H. 1969. Peregrine and Prairie Falcon life tables based on band-recovery data. Pp. 505-509 *in* J. J. Hickey, ed., Peregrine Falcon Populations: their Biology and Decline. University of Wisconsin Press, Madison.

Enderson, J. H., and **D. D. Berger.** 1968. Chlorinated hydrocarbon residues in Peregrines and their prey species from northern Canada. Condor 70(2): 149-153.

Enderson, J. H., D. G. Roseneau, and **L. G. Swartz.** 1968. Nesting performance and pesticide residues in Alaskan and Yukon Peregrines in 1967. Auk 85(4): 683-684.

Enderson, J. H., and **D. D. Berger.** 1970. Pesticides: eggshell thinning and lowered production of young in Prairie Falcons. BioScience 20(6): 355-356.

Hall, G. H. 1955. Great moments in action: the story of the Sun Life falcons. Mercury Press, Montreal. 37 p.

Henny, C. J., and **H. M. Wight.** 1969. An endangered Osprey population: estimates of mortality and production. Auk 86(2): 188-198.

Herbert, R. A., and **Kathleen G. S. Herbert.** 1965. Behavior of Peregrine Falcons in the New York City region. Auk 82(1): 62-94.

Hickey, J. J. 1942. Eastern population of the duck hawk. Auk 59(2): 176-204.

Hickey, J. J. ed. 1969. Peregrine Falcon Populations: their Biology and Decline. University of Wisconsin Press, Madison. 596 p.

Keith, J. A. 1969. The DDE affair. Canadian Field-Naturalist 83(2): 89-90.

Kendall, H. 1968. Breeding Prairie Falcons in captivity. Journal of North American Falconers' Association 7: 57-64.

Mosquin, T. 1969. Toward legislation to protect young Peregrine Falcons. Canadian Field-Naturalist 83(4): 297-299.

Nelson, R. W. In press. *In* Proceedings of the NAFA Peregrine Symposium. R. R. Olendorff, editor. Privately printed.

Peterson, R. 1968. The domestic raising of the Peale's Peregrine Falcon. Journal of North American Falconers' Association 7: 64-67.

Porter, R. D., and **S. N. Wiemeyer.** 1969. Dieldrin and DDT: effects on Sparrow Hawk eggshells and reproduction. Science 165: 199-200.

Porter, R. D., and S. N. Wiemeyer. 1970. Propagation of captive American Kestrels. Journal of Wildlife Management 34(3): 594-604.
Ratcliffe, D. A. 1958. Broken eggs in Peregrine eyries. British Birds 51(1): 23-26.
Ratcliffe, D. A. 1965. The Peregrine situation in Great Britain 1963-64. Bird Study 12: 66-82.
Ratcliffe, D. A. 1967. Decrease in eggshell weight in certain birds of prey. Nature 215: 208-210.
Waller, R. 1962. Der Wilde Falk ist Mein Gesell. Verl. Neumann-Neudamm, Melsungen.
Waller, R. 1968. A report of the first successful breeding of Peregrine Falcons in captivity. Journal of North American Falconers' Association 7: 45-57. Translation by E. H. Spuhler of pp 285-304 of Waller, 1962.
White, C. M. 1968. Diagnosis and relationships of North American tundra-inhabiting Peregrine Falcons. Auk 85(2): 179-191.

R. WAYNE NELSON

Department of Biology
The University of Calgary
Calgary 44, Alberta
August 15, 1970

Pesticides in the Arctic Wilderness

Editor,
The Canadian Field-Naturalist

The following is an exerpt taken from a summer field report of Mr. Keith Hodson who has worked with me as a student assistant during the past three years. Because of his close involvement in pesticide sampling and field surveys of bird of prey populations Keith has been intimately associated with our projects and has experienced personally the tragedy of the declining Peregrine population. This summary which could apply equally to each of his three summers with the Wildlife Service puts convincingly into words the emotions, misgivings and moral implications felt by most people sincerely involved and fully aware of this monumental example of man's lack of an ecological conscience.

RICHARD FYFE

Biologist
Canadian Wildlife Service
Edmonton, Alberta
October, 1970

"In summary, a personal comment on this summer's work is perhaps in order. It has been said that the more one enjoys his work, the faster the time it takes seems to go. It seems like only a few days have passed since I arrived on the prairies last spring and I can truthfully say that this has been the most enjoyable summer's work I have spent. In another sense, however, it has been the most disheartening summer I have known. When a person has become so deeply involved with a living creature as I have with the Peregrine Falcon it becomes difficult to work with them without some degree of emotional involvement, and for myself to survey one area after another where these birds have been and should be found, to find nothing, and to know that they are slowly and surely being poisoned out of existence by pesticides, has been most discouraging.

In 1966 my brother and I paddled a small canoe down the Mackenzie River and it was on this trip I visited my first Peregrine eyrie. There on a ledge high above the river I saw my first young falcons lying in a crevice on a tangled bed of moss and feathers. That year the old hen had circled and screamed and dived at me as I climbed up to her eyrie, and there I had watched in awe as I saw the male hurtle downwards, his pumping wings sounded like the roar of wind through a canvas sail as he closed in on his prey, a jay unsuspecting its pending oblivion until it was dashed into a cloud of feathers by the devastating blow from above.

This year as we landed beneath the eyrie, a sudden tightness gripped me for a strange quietness seemed to surround us, only the lap of water on the shore, the whisper of a light breeze through the ragged spruce trees, and the occasional twitter of some Townsend's Solitaires foraging along the beach could be heard. Half fearful of what I knew I would not find, I raced up the hill, scrambled over the broken talus beneath the cliff and climbed up onto the ledge. Except for a shallow scrape through the moss in one corner and the remnants of a few feathers, it was empty and lifeless. It was then it all hit home to me, of man's ignorance, of his foolishness, and of his apathy to the state of the world around him and what he was doing to it. As I sat there overlooking the great river flowing beneath me and the wide expanse of the arctic tundra beyond, the outlines of two falcons came into vision and I heard the wailing of the old hen, a sound I had heard so often that summer at other deserted eyries, and then the two birds drifted

slowly off into the arctic summer's twilight. I pondered for awhile, wondering if this was all that man's progress was going to yield him, cold stone where once there had been birth and life, low wails where once there had been loud calls of love and of anger and of feeling, and only ghost-like shadows gliding into the sunset?

It was not only what was happening to the Peregrine that bothered me so much, but that this disease of pollution which man was spreading over the face of the earth in the name of progress was slowly growing within all living things. The Peregrine or the Brown Pelican or the loon may be the first ones to succumb, but where was it going to end if man did not realize what he was doing until it was too late?

Our work this summer has been fruitful, it is providing the only weapon with which we can fight the problem of pesticides and pollution — knowledge of what they are doing to the environment we live in. Because of our work last summer the far reaching effects of the use of mercury seed coatings has been faced and a continent wide outcry against the use of these substances has resulted. DDT, the most widely used residual pesticide now in use has been banned in Ontario and a number of states. These are small steps but they are a beginning, and to me, to know that my work, however small, may help in the solution of this problem of pesticides and pollution and is not all in vain is reward enough."

KEITH HODSON

Student,
University of British Columbia

Reviews

Dynamic Zoogeography with special reference to Land Animals

By Miklos D. F. Udvardy. Van Nostrand Reinhold, New York, Cincinnati, Toronto, London, Melbourne, 1969. XVIII & 446 pp. $17.50 (US).

Any author attempting to write a comprehensive text covering terrestrial zoogeography is faced with a nearly impossible task. The literature on the subject is vast and is rapidly expanding. So-called new theories appear regularly, old ones are restated, various "camps" established, and in some areas there is little agreement if not utter confusion.

Syntheses of information are badly needed, and in some areas Udvardy has done a good job of covering the literature. This is particularly true with references dealing with "recent" species. His knowledge of the European literature is excellent, and the bibliography alone is valuable. The book is strongly slanted toward ecological zoogeography at the species level. From the ecological approach the book is a valuable contribution particularly through the assembling of many examples dealing with barriers, dispersal, species distributions, and related subjects. Many of the examples are interesting and well-illustrated and, from this standpoint, the book is well worth having.

As a text attempting to elucidate zoogeographic theory, it has many serious deficiencies. There is an unnecessary preoccupation with words, e.g., why use "anemochore" when "wind dispersed" is easily understood. The scope of "dynamic" zoogeography as defiined in the introduction seems to differ from the discussion of "dynamics" on p. 225 and is esentially synonymous with other authors' "historical zoogeography". A glossary with a concise definition of terms would be of considerable value.

The most serious drawbacks, however, deal with the treatment of theoretical aspects. Whether one agrees or not with the theories expressed in Darlington's "Zoogeography" (1959), there is little excuse for ignoring them. Theories dealing with diversity in the tropics, importance of dominance, time and evolution, zonation, radiation and many other aspects are omitted or superficially treated. Darlington (1959) carefully documents patterns by using genera, tribes and families, while Udvardy (p. 231) states that anything above the species level is "arbitrary" (which is true) and is therefore useless (which is untrue). Because of this attitude Udvardy's book essentially omits historical, pre-Pleistocene zoogeography.

In summary, Udvardy's work is a good reference for ecological factual information on recent species. The discussion of theoretical zoogeography, particularly the historical aspects is poor to non-existent. It can be recommended as a reference but not as a comprehensive text.

Henry F. Howden

Biology Department,
Carleton University
Ottawa, Canada.

Nightshades: The Paradoxical Plants

By Dr. Charles B. Heiser, Jr., 1969. W. H. Freeman and Company, 660 Market Street, San Francisco, California 94104. 200 pp., illus., $5.95 (US).

This book contains an up to date account of the origin, domestication and uses of the many members of the nightshade family utilized by man. A large proportion of the book is devoted to nightshades that are important food plants (Capsicum pepper, Irish potato, tomato, eggplant, husk tomato, tree tomato, lulo, and pepinos). The author convincingly shows that Capsicum pepper, Irish potato and tomato have played important roles in human history. There is an interesting chapter about a group of nightshades, containing powerful alkoloids, that have been used as medicines and as poisons. In another chapter, the introduction of tobacco from America to Europe by early explorers is traced and its subsequent widespread use as a medicine and in smoking is discussed.

The nightshade family also contains some common ornamental plants, the best known of these being butterfly flower and petunia. The author outlines how the vast array of colorful varieties of petunia, now available for flower gardens, were developed from two less spectacular species of *Petunia* that were brought to Europe from South America in the early part of the nineteenth century.

The fourty-three pages devoted to the controversy about the origin and merits of Luther Burbank's Wonderberry seem to occupy a greater share of space in the book than the importance of this plant warrants. The many written exchanges between Burbank and proponents and opponents of Wonderberry, in newspapers and other publications, are unnecessarily detailed. The photographs are of excellent quality but the line drawings are mediocre.

Dr. Heiser Jr. has written a very informative and witty book that has neatly combined scientific accuracy with readability. His book will appeal to a wide audience.

G. A. MULLIGAN

Plant Research Institute
Central Experimental Farm
Ottawa, Canada

A Field Guide to Western Reptiles and Amphibians

By Robert C. Stebbins. Houghton Mifflin Company, Boston. xiv + 279 pp. 1966.

Each new volume of the Peterson Field Guide Series is a major publishing event, but this addition is a particularly splendid example of the careful scholarship and fine illustrations that are the consistent mark of these editions. This is a worthy companion to the earlier (1958) guide to eastern reptiles and amphibians written by Roger Conant.

Dr. Stebbins is not only a painstaking professional herpetologist with long experience with the herpetofauna of western North America but also an artist of consummate skill. All of the 39 plates, 24 of them in colour, the endpapers, and the numerous text drawings amply demonstrate this. The coloured illustrations, in particular, may be the finest of these species ever published.

The subject order of the book is straightforward. An introduction stresses that the book's primary function is identification, and contains a timely plea for the "leave alone, watch, and study" approach to field study of these animals in their natural environment. It defines the area covered as "western North America from a line formed by the eastern boundaries of New Mexico, Colorado, Wyoming, Montana and Saskatchewan north to the Arctic Circle." This opening section also has hints on the most efficient use of the book, and many useful background generalities among which are sex differences, voice, and an explanation of the distribution maps. The introduction is followed by sections on "Making Captures", "Caring for Captives", and "Field Study and Protection." There is an excellent series of four identification keys for major groupings of salamanders, frogs and toads, lizards, and snakes. The major portion of the book (pages 32 to 194) is devoted to species accounts, each species being treated by the headings: identification, similar species, range, and, where applicable, voice and subspecies. The book concludes with sections on "Amphibian Eggs and Larvae" (illustrated), a glossary, a short reference section, 190 range maps and an index. The endpapers give general external features of amphibians and reptiles. The major illustrations are conveniently placed together near the centre of the book, and others are scattered through the book next to the text they illustrate. Many of the illustrations have appeared in previous publications by Dr. Stebbins and these are all fully documented on page 224.

Two hundred and seven species are covered in this book and uncounted subspecies which together range over half a continent. Obviously no book of this scope, however industriously prepared, can be immune from criticism. It is particularly unfortunate for Canadian readers that Dr. Stebbins did not take more care in compiling the Canadian portions of his range maps— to judge from his acknowledgements the only Canadian herpetologists consulted were Paul K. Anderson (Alberta) and Ian McTaggart Cowan (British Columbia). As far as can be seen no effort was made to obtain data from museums in British Columbia, Saskatchewan or Manitoba, nor from the western collections of the Royal Ontario Museum or the National Museum of Natural Sciences. As a result, a few of the Canadian portions of the distribution maps are not as accurate as they could have been. For example, the Red-bellied Snake (map 153) is entirely omitted from Saskatchewan (see Cook and Nero, 1961, Blue Jay 19(3): 134-135), and the type locality for the Boreal Chorus Frog is not included within its range on map 41 (see Cook, 1964, The Canadian Field-Naturalist 78(3): 186-192).

Although the amphibian eggs and larvae section is a welcome addition to a comprehensive field guide, users should be cautioned that it is incomplete in its treatment and in some cases even in-

cluded species that have little worthwhile comment such as the description of the tadpole of the "Dakota Toad" (*B. hemiophrys*) p. 205; "Resembles Western Toad tadpole." In fairness to Dr. Stebbins, this reflects voids in the existing literature, rather than his own lack of industry — it is impossible to examine every species personally in all the aspects one would wish. A bias is perhaps reflected throughout the text for species west of the Rocky Mountains where the author has particularly extensive field experience.

Unquestionably, any western naturalist's or North American herpetologist's bookshelf is inadequate without this handsome volume — and those who have negelected it until now may have done so at their own loss.

Francis R. Cook

National Museum of Natural Sciences
Ottawa, Canada

Eagles, Hawks and Falcons of the World

By Leslie Brown and Dean Amadon. 1968. Sponsored by the National Audubon Society. McGraw-Hill Book Company, New York. 2 vols. 945 pp. $59.50 (U.S.)

This magnificent two-volume work is an admirable assemblage of information on the diurnal birds of prey of the world. It is readably written and well printed (although not entirely without typographic errors) on good quality dull-gloss paper.

Part 1 is made up of 18 chapters containing a total of 150 pages of introductory material. There are thorough treatments of such aspects of these birds as classification and distribution, physical attributes and senses, plumage and molt, the daily cycle, flight, migration, hunting methods, speed, territory, display, nest and nest building, development of the young, care of the young, the post-fledging period, breeding success and productivity, longevity, mortality, enemies and man-hawk relationships. Treatment is full and up to date with much new information especially on behaviour. Interspersed are interesting discussions and speculation regarding various controversial points.

Presumably the text was written before the full impact of pesticides on the birds of prey was realized, for there is little information on this important subject.

Part 2 is devoted mainly to the species accounts, nearly 300 of them. It opens with a chapter on taxonomy and nomenclature and this is followed by one on field identification which consists mainly of useful keys to genera. The species accounts are well organized under such categories as range, broad ecology, description of species (including subspecies), field characters, voice, and general habits. Useful maps showing the world distribution of the birds are grouped together near the end of Volume 2.

The work is superbly illustrated by 165 plates, 125 of them in color. These, the work of eight artists, handsomely illustrate the major variations in the adult and first immature plumages. J. C. Harrison's adult Northern Goshawk shows the iris color yellowish like that of the juvenal whereas it should be red.

There are also 15 plates depicting the underwing flight aspects of the birds. The genus *Falco* seems to be overlooked, however.

The book closes with a useful six-page list of references to additional supplementary literature pertinent to the various subjects discussed. The authors have done a fine job on this vast assemblage of information on a fascinating group of birds, many of which are rapidly losing ground in their fight for life in a man-dominated world.

W. Earl Godfrey

National Museum of Natural Sciences,
Victoria Memorial Building,
Ottawa 4, Canada

Compléments à l'étude des Poissons Actinoptérygiens du Jurassique français

By Sylvie Wenz. Cahiers de Paléontologie. Editions du Centre national de la Recherche scientifique. (15, Quai Anatole, France, Paris VII^e.) 276 pages, 48 plates, 109 text figures. 1967. 120 F.

Ever since the remarkable work of Agassiz in the first part of the 19th century the Jurassic fish of Western Europe have been the subject of a great

deal of research. With the coming of the understanding of evolutionary mechanisms and anatomy, together with new preparation and optical techniques, this research has become increasingly refined, and Mlle Wenz's work provides a worthy addition to previous studies in this field.

The paper makes important contributions at two levels, firstly detailed information supported by fine drawings and photographs on the structure of several groups, and secondly a re-evaluation of the placement and relationships of these groups. Following a short description of the Jurassic deposits, most of the remaining text deals with the descriptions and relationships of the fish fauna.

The problem of higher classification is approached by three paths. Firstly the Chrondrostei, Holostei and Teleostei are redefined and tables of diagnostic characters are presented for them. (The anti-phyletic grade approach is properly rejected). Wenz is aware that individual characters are not absolutely diagnostic and that it is only combinations of several firm characters which will properly define and relate higher taxa. Secondly the characters, their value, variation and limitations are discussed. She finds, for example, that the current use of cephalic sensory canals is not a higher reliable character. Lastly, she discusses the relationships of some of the problematic groups. It is evident that Mlle Wenz has made a valuable contribution towards the understanding of these three major divisions of the actinopterygians.

Fourteen genera contained in nine families are described and discussed, particularly with regard to their ancestry and affinities. Most are from the Lias (Lower Jurassic) although three genera from the Callovian and Kimmeridgian (Upper Jurassic) are also considered.

The subholosteans are represented by *Acidorhynchus* and *Ptycholepis*. The latter is compared with *Boreosomus* and is believed to be derived from it, or from a *Boreosomus*-ancestor, which reaffirms the work of Aldinger and Brough in earlier years.

Mlle Wenz upholds Lehman's classification of the Semionotiformes into the two families Dapediidae and Semionotidae, and the primitive *Acentrophorus* is regarded as an early semionotid. She retains the Lepisosteiformes separate from the Semionotiformes, at least provisionally.

The family Pachycormidae is represented in this work by four genera. *Pachycormus* itself is well described and the detailed diagrams of the skull and axial skeleton are particularly welcome. Woodward's two species of *Pachycormus* are maintained although obviously they are very similar. Among the Furidae (Amiiformes) *Eurycormus* is placed as a form intermediate betwen the furids and amiids, and Wenz considers that the two families were hardly demarcated in Callovian time.

The description of *Leptolepis coryphaenoides*, the type species, is of considerable importance, both with regard to the proper understanding of the genus and to methods of palaeontological taxonomy. The species has been described a number of times and on each occasion further disagreements have arisen with regard to previous studies. The present work clarifies some of the reasons for these discrepancies. It is evident that a large number of individual variations occur within the species and Wenz gives a complete delineation of these, particularly the sensory-canal-bearing bones of the skull roof and cheek regions. Despite these differences it is evident that there is little evidence for splitting of the species as has been sometimes proposed. This serves to exemplify a matter of fundamental importance in palaeo-taxonomy; that is, the great value of a large number of paratypes, wherever possible, to allow for the natural variation found in any population. Only too often have new species been proposed on the scanty evidence of one or two specimens, differing only slightly from other members of the same genus. This is particularly so in the case of *Leptolepis*, a genus which was undergoing a rapid rate of evolution in Jurassic-Lower Cretaceous time, and which, therefore, exhibits a range of mosaic evolutionary features.

In this study *Leptolepis* is considered to be a teleost, mainly on the basis of skull characters, although the caudal region is also used as evidence. The genus is regarded by Wenz as not being ancestral to the higher teleosts, which is in accordance with the most recent thoughts on that subject, although Wenz's reasons for this action seem a little dubious depending as they do on jaw adaptations, which would seem to be unreliable indicators of an evolutionary pathway in this case.

Yet further support is provided for the classification of actinopterygians and particularly halecostomes by use of the internal structure of the caudal region, although this could perhaps have been more heavily emphasized by the author. It is highly significant that while skull elements of *L. coryphaenoides* vary considerably, the caudal region apparently remains stable within the species as far as one can tell. The interpretation of the caudal

region differs considerably from that of previous authors.

The paper is illustrative of many of the problems encountered in palaeontology, particularly those of convergence and the establishment of significant evolutionary (and, therefore, taxonomic) criteria. In this respect it is most interesting to see that the use of sensory canal pathways as such a criterion in holostean evolution is regarded as unreliable by Wenz.

In conclusion it may be noted that the lucid text is further clarified by a large number of excellent diagrams and drawings. The photographic plates are of the highest quality and could well serve as a mark to be aimed at by other authors. The author and publisher may rightfully be proud of this volume.

M. WALDMAN

N.R.C. Postdoctoral Fellow
Palaeontology Division
National Museum of Natural Sciences
Ottawa 4, Canada

D. E. MCALLISTER

Curator of Fishes
National Museum of Natural Sciences
Ottawa 4, Canada

Flora of the Prairie Provinces: A Handbook to the Flora of the Provinces of Manitoba, Saskatchewan and Alberta

By Bernard Boivin. Part I. Pteroides, Ferns, Conifers and Woody Dicopsids. 202 pp. 1967. Part II. Digitatae, Dimerae, Liberae. 185 pp. 1968-1969. Mémoires de l'Herbier Louis-Marie, Faculté d'Agriculture, Université Laval, Québec. Paperback. Available from the author or from The Blue Jay Bookshop, Box 1121, Regina, Saskatchewan. $3.00 per part.

Canadian botanists have long awaited a modern, critical taxonomic treatment of the flora of the prairie provinces. With the appearance of Part II of Boivin's four-part Flora it is evident that we are witnessing the publication of an original taxonomic work, one that will serve as much to stimulate controversy among taxonomists as to serve as a guide to the plants of the Prairie Provinces.

The Flora includes all the native and introduced vascular plants of Manitoba, Saskatchewan and Alberta and, as such, contains a considerable portion of the Canadian flora. Since the manual includes not only the Great Plains and the boreal forest floras, but also portions of the Great Lakes-St. Lawrence forest flora, the southern arctic flora and the cordilleran flora, it should be useful outside the area specifically covered.

The manual contains keys to the families, genera and species. For each species, and for many varieties, there is a diagnostic description, a statement of flowering time, brief ecological notes, generalized distribution, important synonymy, and English and French common names.

Discussions of the distinctions between closely related taxa and of nomenclatural and distributional problems are often included. In the case of morphologically variable taxa, such as *Ranunculus aquatilis* and *Armeria maritima,* keys to varieties, including extraterritorial varieties, are presented and the variation is discussed.

The keys are simple and generally seem to be useful. However, the occasional use of unusual technical terms, such as "diachene" instead of schizocarp for the fruit of the Umbelliferae, the use of obscure or difficult to observe characters, such as "legume sulcate dorsally or not at all sulcate" in *Astragalus* versus "legume sulcate ventrally" in *Oxytropis* instead of the more familiar and useful keel characters, and the occasional use of vague statements, such as "flowers large" versus "flowers smaller", will reduce the usefulness of some of the keys and will require, at least, the inclusion of a glossary in a later part.

The arrangement of the orders and families will immediately strike the reader as unusual. It is based on a system of classification proposed by the author in 1957 (Les familles de Trachéophytes, Bull. Soc. Bot. Fr. 103: 490-505) in which he modifies the Bessey and Hutchinson systems of classification. Taxonomists are generally agreed that the Bessey system more closely reflects the evolution of the angiosperms than does the Engler and Prantl system, commonly used in floras; but the incorporation of the Hutchinson hypothesis that woody plants are more primitive than herbaceous plants leads to the subdivision of the dicotyledons into two lines, the woody Lignidae and the herbaceous Herbidae. This results in the "unnatural" separation of some apparently closely related groups, such as the Araliaceae and the Umbelliferae. Boivin's system while it reveals the author's views on angiosperm phylogeny does not, in my opinion, contribute to the utility of the Flora.

The general appearance of the Flora, reproduced by photo-offset press, is not attractive and it is regrettable that the decision was made to publish it originally in Phytologia, a journal printed by the photo-offset method. It would be desirable, once all four parts have appeared, for the author to make some minor revision, or at least to incorporate the additions and corrections already made, and to republish the work in a single, attractive volume suitable for field use.

The most outstanding feature of Boivin's Flora is that it is the result of a critical taxonomic, floristic and nomenclatural re-evaluation of the flora based on a study of all available herbarium specimens and on the extensive field experience of a competent, classical taxonomist. The taxonomic treatment is often original and the author has not allowed convention or convenience to stand in the way of his species concept. Species which he is unable to distinguish morphologically are combined, many familiar names are relegated to synonymy and many new combinations are incorporated. Some botanists will disagree with his taxonomic decision to combine *Pinus banksiana* (jack pine) and *P. contorta* (lodgepole pine) as varieties of one species (*P. divaricata* var. *divaricata* and var. *latifolia*); but his nomenclatural decision to use *divaricata*, which has priority, as the proper specific epithet eventually will find acceptance.

I cannot fully agree with his taxonomic treatment of *Salix*; but his combining *S. glaucophylloides* and *S. laurentiana* under the latter name seems to be valid and I am now re-examining the *lucida-lasiandra-caudata* and the *pellita-drummondiana-subcoerulea* groups in the light of his decision to treat them, respectively, as *S. lucida* and *S. pellita*. Time will tell just how many of Boivin's taxonomic judgements will be accepted and how many will be rejected by taxonomists; but his nomenclatural decisions seem to be basically sound and the taxonomic controversy that he will have generated will more than justify his courage and labour.

GEORGE W. ARGUS

Canadian Forestry Service,
Ottawa, Canada

The Killers

By D. P. Mannix. Clarke, Irwin and Co., Toronto. 255 pp. 1968. $7.20.

Troubled Waters

By D. P. Mannix. Clarke, Irwin and Co., Toronto. 247 pp. 1969. $8.35.

These books, one about a fighting cock, the other about a goldfish, are filled with both good natural history and anthropomorphism. They are pleasant stories, well told, easily read, with accurate ecological detail. The animals do not talk, but they think, and decide, and tiptoe, and they are generally react mentally as would people. I have been warped enough by science to find this sort of writing disturbing, but I wonder too if it does not fill a real need. I doubt that I was badly damaged by Thornton Burgess, Charles G. D. Roberts, and others whose animal stories science would snub. Writers like these have spread knowledge and delight as few scientists can do, and as almost none want to do. Until scientists can communicate entertainingly with the public, good observation told with anthropomorphism will have to be the best that is available.

YORKE EDWARDS

Canadian Wildlife Service,
Ottawa, Canada

Carl Rungius: An Artist's View of Nature

By L. E. Render (and D. A. E. Spalding). 1969. Publication No. 1 of the Provincial Museum and Archives of Alberta. 24 pp. Queen's Printer, Edmonton. Price not given.

Carl Rungius has been a standard of perfection in big game art through most of this century. Born in Germany and a long time resident of New York, he discovered the Canadian Rockies in 1910, then spent most summers there until his death in 1959. Canada — and Alberta — can both claim him as partly their own.

This first publication of Alberta's Provincial Museum and Archives is a brief account of the man, a fine presentation of his art reproduced in part in full color, and a catalogue for a show of his art on display in the museum. The art there is on loan from the Glenbow Foundation.

It is an impressive production, magazine-like, containing eight colour plates, five half tone plates, and about 22 sketches and studies of animals. Brief articles examine the man, his art, and his ability as a naturalist.

His art is good. Rungius was always good, it seems. But the small biography given of Carl Rungius does not ring quite true. Most of the facts are there in brief, but some essential points are missing. To understand Rungius and his art, one must recognize his viewpoint as basically that of the central European hunter. This is a trophy oriented approach that seeks mainly the largest and finest specimens, and which admires especially this size and quality in the horns and antlers of hoofed animals. In a sense this is a cult of admiration for the atypical. For this reason most of his art shows males, always they are magnificent examples, and usually they are shown in the hunting season when the animals are in prime condition, and when, in the deer, antlers are present and at their best. Rungius was a naturalist, as this publication indicates, but in a very special sense. He produced paintings that were ecologically correct. But his idealistic approach exalting the exceptional borders on fairy tale that is only just believable.

As the authors point out, Carl Rungius was an artist and naturalist who produced a magnificent record of Canadian wildlife in its wild and scenic environments. This small publication gives a fine glimpse of the man and his art, as well as of a negelected part of the Canadian scene.

YORKE EDWARDS

Canadian Wildlife Service
Ottawa, Canada

A Guide to the Flora of Elgin County, Ontario

By William G. Stewart and Lorne E. James. Catfish Creek Conservation Authority. xxii + 118 pp. 6 maps offset. 1969. Available from Catfish Creek Conservation Authority, 122 Talbot Street, St. Thomas, Ontario. $1.50 plus .25 postage.

A list of the plants which occur in any area is always a useful contribution to our knowledge of that area. This is another of several 'county lists' which have appeared in recent years for various counties of Southern Ontario. It might, however, better be called an annotated list than a guide.

A total of 1001 latin names are listed in taxonomic sequence, together with comon names. Sites where the plants have been collected are recorded by lot and concession, date of collection and habitat. No atempt is made, however, to assess abundance or distribution within the County. There is too, some duplication, e.g. *Geum aleppicum* is undoubtedly either var. *strictum* or var. *cuneatum* and *Mentha arvensis* probably belongs to var. *villosa*. This is probably the result of the same Taxon being submitted to different authorities, or the same authority at different times.

Twenty-two pages are devoted to foreword, introduction, biographical sketches of the authors and physiography. Appendices give a list of Musci and Hepaticae, and a list of species which are known from adjacent counties but not collected in Elgin County by the authors, but which should be searched for. Indices to families and genera complete the volume.

W. J. CODY

Plant Research Institute,
Central Experimental Farm,
Ottawa 3, Canada

Catalogue des espèces de Poissons déposés au Musée de la Station de biologie marine de Grande-Rivière (Gaspé-sud) 1932-1969

By Julien Bergeron and Vianney Legendre. Québec Ministère de l'Industrie et du Commerce, Service de Biologie, Cahiers d'Information (51): 1-86, 2 figures.

Despite the interest in fishes, few regional lists of species have been published for the Atlantic coast of Canada. The present catalogue conveniently arranged, gives station and species lists for the Gulf of St. Lawrence, notably the estuary of the St. Lawrence River and Chaleur Bay. Three maps show the stations. The list is all the more valuable because it covers a considerable span of time — 38 years.

Eighty-two species are recorded. Amongst other varieties established by the list are *Notolepis rissoi*, *Notacanthus nasus*, *Melanostigma atlanticum*, and *Cryptosarus couesi*. Certain records are not included in Leim and Scott's *Fishes of the Atlantic coast of Canada*. Occasionally the nomenclature is out of date.

This catalogue is a valuable contribution to our knowledge of fishes of the Gulf of St. Lawrence.

D. E. MCALLISTER

Curator of Fishes
National Museum of Natural Sciences
Ottawa, Canada
20 July 1970

Other New Titles

A Bibliography of the Lake Trout ***Cristivomer Namaycush*** **(Walbaum), 1929-1969.** K. E. Marshall and J. J. Keleher. Fisheries Research Board of Canada Technical Report No. 176. 60 p. Mimeo.

The Storm Petrel and the Owl of Athena. L. J. Halle. Princeton University Press, 1970. Illustrations and maps. 268 p. Studies of Pelagic sea birds on the Shetland Islands during the nesting season. Also other observations and essays.

Petroleum Resources under the Ocean Floor. National Petroleum Council, Washington, D.C., 1969 Illus. 108 p. Paperback. Ca. $3.

Fish in Research. Otto W. Neuhaus and John E. Halver (Eds.). Academic Press, 1970. Illus. 311 p. $9.

Approaches to Animal Communication. Thomas A. Sebeok and Alexandra Ransey (Eds.). Humanities Press, 1970. Illus. 261 p. $15.

Chemicals and Life. Kenneth E. Maxwell. Dickenson Publishing Co., 1970. Illus. 372 p. Paperback $5.95 (US). Considers the sensitivity of living systems and organisms to chemicals in the external and internal environments. Deals with pesticides, birth control, eutrophication, radiation, etc.

The Buffalo. F. Haines. Crowell Publishers, 1970. Illus. 242 p. Deals with the American Bison and their hunters from prehistoric times to the present. $8.

The Flies of Western North America. Frank R. Cole and Evert I. Schlinger. Univ. of California Press, 1970. Illust. Maps. 693 p. $25. (US). Includes accounts of more than 8000 species.

Handbook of Freshwater Fishery Biology. Vol. I. Life History Data on Freshwater Fishes of the United States and Canada. (excluding the Perciformes. Kenneth D. Carlander. Iowa University Press, 1969. Illust. 792 p. $15. (US). Revision of the 1953 handbook of Freshwater Fishery Biology.

The Hudson River: A Natural and Unnatural History. Norton, 1969. Illus. 304 p. $7. An excellent account of this river, section by section with its flora and fauna, geology, history and with the impact of pollution.

The Wolf: The Ecology and Behavior of an Endangered Species. L. David Mech. Natural History Press, 1970. Illust. 384 p. A detailed scientific study of behavior of the wolf and its place in the wilderness. $10.

Meteorological Aspects of Air Pollution. World Meteorological Organization. Unipub, N.Y., 1970. Illus. 75 p. $4.95.

The Weasels: A Sensible Look at a Family of Predators. B. Gilbert. Pantheon Books, 1970. Illus. 201 p. Considers many members of the weasel family, Mustelidae — weasels, ferret, mink, marten, skunks, otter, badger and wolverine.

Universities, National Laboratories, and Man's Environment. Argonne Universities Association, Conference, Chicago, Ill. U.S. Dept. of Commerce, Springfield, Virginia, 1969. Illus. 167 p. $3.

Congress and the Environment. R. A. Cooley and G. Wandesforde-Smith. (Eds.), Univ. of Washington Press, Seattle, 1970. Illus. 284 p. $8.95 (US).

Mammals of Hawaii. A Synopsis and Notational Biography. P. Quenton Tomich. Bishop Museum Press, Honolulu, 1969. Illus. 240 p. Bernice P. Bishop museum Special Publication No. 57. $5.50.

Hunting For Dinosaurs. Zofia Kielan-Jaworowska. Translated from the Polish. M.I.T. Press, Cambridge, Mass., 1969 Illus. 178 p. $8.

Natural Areas; Needs and Opportunities. James L. Trappe (Ed.). Northwest Scientific Association Symposium held March 27, 1970. Available from Continuing Education Publications, Waldo 100, Corvallis, Oregon 97331. Deals with what natural areas are, why we need them, how they are managed and used and future needs and prospects. $3. (US).

Defence against Famine: The Role of the Fertilizer Industry. A. V. Slack. Doubleday, 1970. Illus. 232 p. Paperback $1.95; Cloth $5.95 (US). Sponsored by the Manufacturing Chemists' Association. Gives a brief history of the Fertilizer Industry and the role of

various chemicals as fertilizers. Shows implicitly how fertilizers have contributed their share to bringing on the massive population problem.

The Environmental Crisis: Man's struggle to live with himself. Harold W. Helfrich, Jr. (Ed.). Yale University Press, 1970. 187 p. Paperback $1.95. Includes papers by experts in science, law, regional planning, economics and government.

The Worlds of Ants, Bees and Wasps. Brian Vewey-FitzGerald. Transatlantic Arts, 1969. Illust. 117 p. $6.50. Written for the good amateur.

Distributional Checklist of the Fishes of New Brunswick. Stanley W. Gorham. The New Brunswick Museum, Saint John, N.B., 1970. 32 p.

Panel Reports of the Study of Basic Biology in Canada. Kenneth C. Fisher. Biological Council of Canada. Includes 26 panel reports. Obtainable from Dr. E. J. LeRoux, Assistant Director General of Institute, Research Branch, Canada Department of Agriculture, Ottawa. $7.

The Niagara Escarpment Study: Conservation and Recreation Report. Leonard O. Gertler. Obtainable from the Niagara Escarpment Study Group, Regional Development Branch, Treasury Department, 950 Yonge Street, Toronto 5, Ontario. 8½ x 11 Maps and Illustrations 96 p.

The Encyclopedia of Marine Resources. Frank E. Firth, (Ed.). Van Nostrand Reinhold, New York, 1969. Illus. 740 p. $25.

Fauna of Sable Island and its Zoogeographic Affinities. H. F. Howden, J. E. H. Martin, E. L. Bousfield and D. E. McAllister. National Museums of Canada Publications in Zoology No. 4. 4 tables, 1 plate, 2 maps, 45 pages, Free.

Aquatic Diptera. O. A. Johannsen. Part 5 by Lillian C. Thomsen. Entomological Reprint Specialists, East Lansing, Michigan, 1969. Illus. $11.25.

The World of the Bison. Ed. Park. Lippincott, Philadelphia, 1969. Illus. 162 p. $5.95. Living World of Books.

Family Planning Today. Alan Rubin (Ed.). Davis, Philadelphia, 1969. Illus. 150 p. Paperback $2.25.

National Parks and Reserves in Australia. Australian Academy of Science, Canberra, 1968 Map plus 46 p. Paperback.

Principles and Practices of Incineration. Richard C. Corey (Ed.). Wiley-Interscience, New York, 1969. Illus. 308 p. $15. Environmental Science and Technology.

The Hungry Future. René Dumont and Bernard Rosier. Translated from the French by Rosamond Linell and R. B. Sutcliffe, Praeger, New York, 1969. Illus. 272 p. $6.95.

The World Food Problem: A Guardedly Optimistic View. W. W. Cochrane. Crowell, New York, 1969. 334 p. $7.95.

Seeds of Change: The Green Revolution and Developement in the 1970's. L. R. Brown. Praeger, New York, 1970. Paperback $2.50.

Causes and Implications of an Observed Sex Differential in the Survival of Wapiti. Donald R. Flook. Canadian Wildlife Service Ottawa, Report Series No. 11. Illus. 71 p. $1.25.

Anonymous. 1969. Interim Report on the Control of DDT use in the Province of Ontario. Advisory Committee on Pollution Control to the Minister of Energy and Resources Management, Queens Park, Toronto. 66 p.

The Rape of the Environment: A Statement of Environmental Pollution and Destruction in Canada. J. M. Dunbar, Canadian Society of Zoologists, Montreal, 1969. 40 p.

Pesticides and Reproduction of Birds. Peakall, P. B., 1970. Scientific American 222(4): 72-78.

Since Silent Spring. F. Graham, Jr., Houghton Mifflin Co., Boston, 1970. 333 p. (Special Consumer's Union Edition, $2.).

The Albatross of Midway Island: A Natural History of the Laysan Albatross. Mildred L. Fisher. Southern

Illinois University Press, 1970. 60 photographs, maps 160 p. $6. A Scientific study of behavior and during the mating and nesting season. Observations on reproduction.

Use of Pesticides and Control of Economic Pests in Indonesia. H. P. Oei-Dharma. Brill, Leiden, Holland, 1969. Illus. 200 p. 42 G.

A Voyage of Discovery and Research in the Southern and Antarctic Regions during the years 1839-1843. By Captain Sir James Clark Ross. 2 vols. David and Charles Reprints, 1969. 8 (U.K.).

Birds of the British Isles and their Eggs. Edited and Revised by J. A. G. Barnes, from the three-volume work by T. A. Coward. (Warne, Wayside & Woodland Series. Illus. 359 p. £2 15s. (UK).

Biogeography and Ecology of South America. E. J. Fittkau, J. Illies, H. Klinge, G. H. Schwabe and H. Sioli (Eds.). Junk Publishers, The Hague, 1968-69. 2 vols. Illus. 946 p. $21. per volume. Monographiae Biologicae. Vols. 18 and 19.

Marine Mammals of British Columbia. G. C. Pike and I. B. MacAskie. Fisheries Research Board of Canada, Queen's Printer, 1969. Illust. 54 p. $1.50.

Pleistocene Mollusca of Ohio. Aurèle la Rocque. Department of Natural Resources, Columbus Ohio, 1970. Bulletin No. 62.

The Myth of the Vanishing Peregrine: A Study in the Manipulation of Public and Official Attitudes. Frank L. Beebe. Privately printed, 1970. Available from Frank L. Beebe, 7619 East Saanich Road, Box 37, Saanichton, British Columbia. 37 p. $1.00.

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist will be open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

(See Instructions to Contributors inside back cover)

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

Normally, only solicited reviews are published. The editor invites biologists and naturalists to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "Other New Titles".

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

Instructions to Contributors

Manuscripts

Authors should submit two manuscripts (original and carbon copy), each complete with abstract, tables, and illustrations. Manuscripts should be typewritten on paper measuring 8½ x 11 inches. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Words meant to appear in italics should be underlined. Every sheet on the manuscript should be numbered.

Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text in all manuscripts except in letters to the editor. In no case should any words be abbreviated; this includes references to tables and figures as well as literature citations.

The tables should be titled and numbered consecutively in arabic numerals. Tables should be placed each on a separate page after the Literature Cited. Captions to figures should be typed together on one page. Authors are requested to use at least one given name.

The **Style Manual for Biological Journals** is recommended, in general, as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be as determined by the editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Coordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted without space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly 7½ × 5¾ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors are asked to share the cost of publication by paying $22.00 for each page in excess of six journal pages. The cost of illustrations and the setting of tables and of small-sized type are also normally charged to the author.

Reprints

Reprints, with or without covers may be purchased. The cost is given on the reprints order form which is attached to the galley proofs. Members in good standing can request a 10% reduction in reprint costs.

Affiliated Societies

Edmonton Bird Club

President, P. H. Thompson; *Honorary President,* R. Lister; *Past President,* J. C. Finlay; *Vice-President,* K. W. Smillie; *Treasurer,* R. Heath; *Field-Secretary,* R. W. Turner; *Audubon Representative,* P. Demulder; *Secretary,* Miss M. J. Wade, 6519 94 St., Edmonton, Alberta; *Librarian,* Mr. A. W. Rupp, 97 Westbrook Dr., Edmonton 76, Alberta.

Calgary Field-Naturalists' Society

Address: Box 981, Calgary 2, Alberta, *President,* Dr. John Powell; *Vice-President,* Peter Karston; *Secretary,* W. Garry McKay; *Treasurer,* Margaret Powell; *Directors,* Mrs. Hattie Boothman and Dr. M. T. Myres; *Editor,* The Calgary Field-Naturalist, John W. Price.

McIlwraith Field Naturalists' Club

President, Mr. Ted Maddeford; *Past President,* Dr. W. H. Minshall; *Vice-President,* Mrs. Spencer Inch; *Corresponding Secretary,* Miss Margaret Ross, Apt. 9, 179 Oxford Street East, London; *Treasurer,* Mrs. Walter Wake, 1354 Longmuir Ave.; *Chairman Audubon Films,* Mr. G. Fred Bates, 366 Burlington Crescent, London; *Chairman Conservation Council,* Mrs. P. W. Tracey, 261 Briscoe St., London; *Editor,* Cardinal—Dr. Frank Cook, 1 Larkspur Crescent, London, Ont.

Vancouver Natural History Society

President, Mrs. W. J. Smith; *First Vice-President,* Mr. A. W. Greenius; *Second Vice-President,* Mrs. J. M. Anderson; *Treasurer,* Mr. E. G. Barnes, Box 3021, Vancouver 3, B.C.; *Corresponding Secretary,* Mrs. H. Pinder-Moss; *Membership chairman,* Mrs. E. Barnes; *Editor,* VNHS Bulletin, Mrs. R. A. Pilkington.

Nova Scotia Bird Society

President, Dr. Eric Mills; *Vice-President,* Dr. B. K. Doane; *Past President,* Mr. Ian A. McLaren; *Editor,* Mrs. J. W. Dobson; *Membership Secretary,* Miss E. Crathorne; *Secretary-Treasurer,* Miss M. Claydon, c/o Nova Scotia Museum of Science, Spring Garden Road, Halifax, Nova Scotia.

Province of Quebec Society for the Protection of Birds

President, Mr. M. D. Spencer; *Vice-Presidents,* Mrs. E. S. Cooper, M. H. Ouellet; *Honorary Treasurer,* Miss G. E. Hibbard; *Honorary Secretary,* Mrs. G. H. Wightman, 40 King's Rd., Pointe Claire, P.Q.; *Librarian,* Mrs. E. Brosseau.

Toronto Field Naturalists' Club

President, Mr. John A. Gingrich, 225 Coldstream Ave., Toronto 12, Ontario; *Vice-President,* Mr. Clive Goodwin; *Secretary,* Mrs. H. Robson, 49 Craighurst Ave., Toronto 12, Ontario; *Treasurer,* Mrs. F. F. Mathers; *Editor,* Mr. Elmer Talvila; *Junior Club,* Mr. Robert MacLellan, 416 St. Clements Ave., Toronto 12, Ontario.

The Saskatchewan Natural History Society

Honorary President, Fred G. Bard; *President,* Gordon Silversides; *Past President,* W. A. Brownlee; *First Vice-President,* J. A. Wedgewood; *Treasurer,* George R. Dodd, 33 Malone Crescent, Regina, Sask.; *Corresponding Secretary,* Mrs. Leith Knight, 843 Elgin Avenue, Moose Jaw, Sask.; *Editor,* The Blue Jay, George F. Ledingham, 2335 Athol St., Regina, Sask.; *Assistant Editors,* Margaret Belcher and Robert W. Nero; *Editor of* Newsletter, James Slimmon, 2526 Hanover Ave., Saskatoon, Sask.

THE CANADIAN FIELD - NATURALIST

PUBLISHED BY

The Ottawa Field - Naturalists' Club

BOX 3264, POSTAL STATION 'C'
OTTAWA 3, CANADA

Second Class Mail Registration No. 0527
Return postage guaranteed

The CANADIAN FIELD-NATURALIST

Published by THE OTTAWA FIELD-NATURALISTS' CLUB, Ottawa, Canada

Volume 84, No. 4 Ottawa October-December, 1970

The Canadian Field-Naturalist

The Canadian Field-Naturalist is published quarterly by the Ottawa Field-Naturalists' Club with the assistance of affiliated societies and of a contribution from the Canadian National Sportsmen's Show. All material intended for publication should be addressed to the editor. Opinions and ideas expressed in this journal are private and do not necessarily reflect those of the Ottawa Field-Naturalists' Club or any other agency.

Membership and Subscription

The annual membership fee of $5.00 for individuals covers subscription to the journal. Libraries and other institutions may subscribe at the rate of $10.00 per year (volume). Applications for membership, subscriptions, changes of address and undeliverable copies should be mailed to: Treasurer, Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa 3, Canada. Return postage guaranteed.
Second class mail registration number 0527.

Back Numbers

Prices of back numbers of this journal and its predecessors, (TRANSACTIONS OF THE OTTAWA FIELD-NATURALISTS' CLUB, 1879-1886, and the OTTAWA NATURALIST, 1889-1919), are obtainable from the Business Manager.

Cover Photograph: Climbers near summit of Mt. Athabasca, Columbia Icefields, near divide between Jasper and Banff National Parks. See article on New Developments Proposed for Canada's Rocky Mountain National Parks by Stephen Herrero. Photo courtesy of the author.

I would like to become a member of THE OTTAWA FIELD-NATURALISTS' CLUB and to receive the quarterly journal THE CANADIAN FIELD-NATURALIST

Name (Dr., Mr., Mrs., Miss) ....
(In block letters)

Address ....

....

....

....
(Include postal zone)

I would like my membership to start with

January of 1970 ☐

January of 1971 ☐

My membership fee of $5.00 is enclosed.

....
(Signature)

(Mail to) Treasurer,
Ottawa Field-Naturalists' Club,
Box 3264 Postal Station 'C',
Ottawa 3, Canada.

Please note that all library and institutional subscriptions to THE CANADIAN FIELD-NATURALIST are $10.00 a year (volume)

The Canadian Field-Naturalist

Volume 84 | OCTOBER-DECEMBER, 1970 | Number 4

TABLE OF CONTENTS

Articles

Notes

Special Notice

Mailing date of previous issue, December 20, 1970

Mailing date of this issue, March 31, 1971

New Developments Proposed for Canada's Rocky Mountain National Parks

Stephen Herrero
Environmental Sciences Centre (Kananaskis)
University of Calgary

Canada's Rocky Mountain National Parks began in 1885 when ten square miles surrounding hot mineral springs near Banff Station were set aside because of their ". . . promise to be of great sanitary advantage to the public . . .". Two years later, the Banff Hot Springs Reserve was enlarged to 260 square miles and dedicated as "a public park and pleasure ground for the benefit, advantage and enjoyment of the people of Canada". Today four parks, Banff, Kootenay, Jasper, and Yoho, each with boundaries contiguous to at least one of the other parks, together encompass almost 8,000 square miles and represent a magnificent and inspiring sample of the northern Rocky Mountains.

For persons fortunate enough to appreciate natural history and splendour these Rocky Mountain National Parks are places of discovery, learning, harmony, and great beauty. From the parks' present highway system even the casual visitor can glimpse extensive cordilleran glaciation on peaks which were at one time ancient sea bottoms. In summer one can drive to the small visitor development now present at the Columbia Icefields, pay for a snowmobile ride, and in a short while be on the Icefields, one of the largest continuous mountain ice sheets in North America. On the same drives which introduce the visitor to the physiography of the Rocky Mountains, wildlife is usually also abundant. Representative large mammals, often seen near roads, have helped to make the parks famous. Elk, deer, and Rocky Mountain Big Horn Sheep are commonly seen, and only slightly more elusive are the moose, mountain goats, coyotes, and black bear. Modern urban-type facilities at Banff and Jasper and an extensive campground system in several of the mountain valleys are available to the traveller, and make motor tours of the park easy and pleasurable.

Historically the parks were developed and popularized by the Canadian Pacific Railway which today controls significant developments in Banff, Jasper, and at Lake Louise. A stay at the C.P.R.'s historic Chateau Lake Louise or at the castle-like Banff Springs Hotel is an experience in itself, and a sufficient attraction to draw thousands of visitors each year. The Jasper Park Lodge and Banff Springs Hotel have only recently remained open in winter but they now cater to increasing numbers of downhill ski enthusiasts which are served at developments within each park. At the Banff Springs Hotel, tourists can rent snowmobiles by the hour and explore parts of the surrounding Spray River Valley. Thus nature is being exposed to new rhythms near the park townsites. For many visitors, townsite conditions are restatement of urban conditions albeit in a spectacular montane environment.

The developed areas within the Parks contrast sharply with the overwhelming majority of this vast park system which is still wilderness. Here the Ski-Doo, the automobile, asphalt strips, and the iron horse are only memories in the minds of human visitors who must come and go on foot or horseback. In the wilderness heart of these parks nature is as she was before man, and man can glimpse what he was before the fantastic but recent human demographic transformation which began 10,000 years ago with the Neolithic shift.

In certain alpine areas, such as the upper reaches of the Cascade Valley, man may enter into an ecosystem in which he is not the dominant species — here the grizzly bear still reigns supreme. Visitors here must be alert and instead of firearms must be armed with knowledge of the great bear's behaviour and sensitivity to his habitat. In the extensive cordilleran icefields, visitors are again reminded of their

frail place in nature and while mistakes can be paid for with tragedy, rewards for the modern-day explorer are often immense.

In 1967 four young men on cross-country skis set out to traverse the glacial backbone of the parks. On hundred and eighty miles from near Jasper to near Lake Louise they travelled on these thin wooden skis. For one month they lived with the rhythm and challenge of this demanding environment. They faced many problems and lived amongst awesome beauty that became a part of them. Trip's end, inevitably at the highway, and the roar of a few trucks shocked them. The first day back in the city was overpowering. What they discovered, however, in that mountain vasteness they have never lost and each of them was uniquely altered by this tremendous wilderness experience.

Encounters with the grizzly, the wolf or the unbroken cordilleran vastness are apex experiences, and can be lifetime moulding events. Intimate discovery of the rhythm of nature on her terms, where man is but a transient leaving no permanent effect is the central theme of these peak experiences. Not everyone is prepared for this and thus far the vast majority of visitors have settled for glimpses at the edge of the vastness. For those who have penetrated deeply there is unanimity in the quality and the depth of the experience which they shared. It is in the parks' wilderness cores that the highest quality experience comes; here that new dimensions of the self are illuminated and throbbing mental and physical health may spring from nature — the original source.

The intensity and benefits of wilderness experience in these parks is fact, not opinion. Here many people have had what the psychologist Maslow calls "peak experiences," ecstatic moments, happy moments, moments of rapture. These persons, while only a small fraction of present park users, have seen in the quality of their experiences something they want preserved for present and future generations, something they want others to be given the opportunity to discover.

There is a myth that Canada is full of wilderness. This falsehood is particularly apparent in southern Canada where most urban development lies. The present unique contribution of the Rocky Mountain National Parks is that they represent extensive wilderness in close proximity to urban centres such as Calgary, Edmonton, Seattle, and Vancouver. As wilderness they offer maximum contrast to the urban environment. Because of the proximity to urban centres they now face development proposals which threaten to alter their basic character.

In December of 1969 the National and Historic Parks Branch of the Department of Indian Affairs and Northern Development presented to the public a set of provisional Master Plans, stating the branch's proposals for the future of the Rocky Mountain National Parks. The public has been asked to comment on these plans and the service has promised to listen and respond to the comments.

Presently, Canada's national parks are "dedicated to the people of Canada for their benefit, education and enjoyment . . ." but, "such parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations." The paradox in this guiding statement has been recognized for years: how is use for benefit, education, and enjoyment to be reconciled with the requirements that the parks should be left unimpaired for future generations? Clearly this is impossible and the problem becomes one of deciding upon the relative weight to be given to use as opposed to impairment. All artifacts of man are impairment or alteration of a natural (not man influenced) environment. Yet certain disturbances are required if man is to use these areas. In the past increased use has meant increased human influence on landscape, flora, and fauna, although these influences need not be so obvious in a well-planned and innovatively-run park which seeks the firm protection of natural features coupled with maximum human use compatible with this goal. Because the Canadian National Parks Act contains the paradox of use and protection, the direction which the parks will take is subject to the interpretations and values of relevant government personnel. But the opinions of

Jasper townsite, Jasper National Park. Note railway cars in lower left. Mt. Edith Cavell in centre.

government officials supposedly reflect the will of the public, and the public is being given voice in the master plan hearings.

Clearly these national parks cannot be all things to all people. The purist, or wilderness-oriented user, finds no solace in the other Canadian public lands. As yet there is no federal wilderness system in Canada, and not one of the provinces has effectively protected wilderness areas. The wilderness user, however, finds himself at odds with the administration and a public which is becoming increasingly facility-oriented and mobile, especially with the use of private automobiles and the recently developed over-snow vehicles.

The master plans are lengthy and detailed documents yet significant themes and major concepts can readily be identified. Foremost is acceptance and encouragement of the automobile. An extensive new system of roads is proposed which if completed will alter the wilderness character of these parks and will result in major landscape, floral and faunal changes. Some of the major roads which are proposed would penetrate the Cascade and Pipestone Valleys and the Howse Pass, all in Banff Park, the Poboktan Pass area in Jasper Park, and the Amwiski, Ottertail, and Little Yoho Valleys in Yoho Park. The rationale for these new roads is in each case the same; they are necessary so that the public may glimpse, with the aid of their private vehicle, some of the great scenic wonders of these parks. The dictum of public use is given high priority while impairment is only lightly considered. Many areas to be penetrated by roads have not been adequately studied, and their natural resources are not understood in any detail. The impact which the proposed roads will have can only be guessed, and perhaps will never be fully known. In some of these areas such as the Cascade Valley, Howse Pass, and Maligne Poboctan, signi-

Black Bear at den mouth. Mt. Norquay, Banff National Park

ficant populations of grizzly bear exist which would be seriously disturbed by public access roads. There is not one single proposal for removal of an existing road or facility.

Another major feature of the plans is the introduction of a zoning system in which all the parks land is divided into one of five major categories: (i) special areas, (ii) wilderness areas, (iii) common natural environment areas, (iv) general outdoor recreation areas, (v) intensive use areas. Simply defined, categories (i) and (ii) are areas where nature is given priority, categories (iii), (iv) and (v) are those in which man's impact on nature is present, varying only in degree. There are a number of problems with the zoning scheme. Perhaps the most glaring is the emphasis given to human use. This is reflected in the fact that over 45 percent of Banff National Park is classified in Zones (iii), (iv) or (v). Facilities and roads if installed to the extent proposed would occupy all the major valley bottoms, encroach and damage major wildlife habitat, and leave wilderness (in name only) to mountain peaks.

Proposed and possible development of visitor service centres at Lake Louise, Saskatchewan River Crossing, and at Pocahontas also threaten

to alter the natural character now present in the parks. Again, no proposals are made to remove existing facilities although a strong case could be made for removal of certain townsites such as Field, B.C.

The expansion of facilities at Lake Louise, a foregone conclusion even before the master plans were brought forth, must be regarded as fact rather than proposal. Central to the multi-million dollar development soon to begin there is the new complex of indoor accommodations and lounge areas, geared primarily to attract the downhill skier, but also available to attract tourists in summer. Downhill ski areas in the Rocky Mountain National Parks were first introduced in the 1930's, and significantly developed during the 1950's. Downhill ski facilities perhaps were reasonable at a time when there were fewer people, less mobility, and less vision that truly natural areas were fast receding in Canada. The expansion of lodging facilities keyed to downhill skiing within a national park is outmoded in terms of present accepted concepts of national park use elsewhere (see for instance the International Union for the Conservation of Nature Definition of National

PHOTO: COURTESY DONALD HUTTON and DAVID SHACKLETON

View of Cascade Valley looking southwest from "Flint's Park" area. Palliser Range in background whose slopes are critical winter habitat for significant populations of Rocky Mountain Bighorn Sheep and Mountain Goats.
Proposed road and associated increase in the number of automobile visits to the area would alter traditional movement patterns of these species.

Jasper National Park; town dump, summer 1968. This dump is now closed.

Parks, or the facilities now permitted in National Parks in the United States). Moreover, these facilities are designed to cater to the elite socio-economic class which the downhill skier epitomizes and there is no way in which such facilities can be construed as leaving the parks unimpaired for future generations.

Lake Louise is situated very near fragile alpine areas which already suffer from over-use. Can a four- or five-fold increase in visitors mean less human impact on this area? The presently inadequate Lake Louise dump only last fall was recorded as having 23 grizzly bears visiting it, along with an uncounted number of human beings. The grizzly does not mix well with human visitation and impact. Will the grizzly, the wilderness symbol of the parks, remain in the Lake Louise area, if so what

This grizzly sow, seen here at the Lake Louise dump, Banff National Park, had two or three cubs. When a Lake Louise employee's dog ran barking at the bear family, the sow left the cubs and attacked the dog's owner. The man luckily received only minor injuries before the sow rejoined her family. The incident occurred at the base of the Olympic double chair lift in May, 1968. In October, 1970 there were 23 grizzlies at the Lake Louise dump in one evening. Lake Louise is cited for very significant expansion of facilities.

problems will it cause, and if not who will pay for the unspeakable impairment which would be caused by its demise?

I'm told that too much money has already been invested in Lake Louise to turn back "progress" there. The Lake Louise Development Corporation, sensitive to its public image and worried about public outcry, has employed Dr. Ian McTaggart-Cowan, one of Canada's foremost conservationists as an ecological consultant. Let us hope that he can approach the solution of the impossible and that if he does the company's backers, mainly Imperial Oil, listen to him.

The proposed development at Saskatchewan River Crossing, in Banff Park, and at Pocahontas in Jasper Park should never be built unless all attempts fail to locate services at nearby areas outside of the parks.

One major development remains to be mentioned, this is the Great Divide Trail System which when completed will run over 350 miles from the Kananaskis Lakes near the Southern boundary of Banff National Park to Mt. Robson Provincial Park in B.C. Parts of the trail would go through each of the four Rocky Mountain National Parks, and traverse scenic climax areas of great interest and variety. The goals of the Trail System, to get people away from their automobiles and into the natural cores of the park, are admirable, yet great caution must be exercised in the development of the trail system or else "impairment" may override the benefit of expanded use. A system of shelters is proposed at approximately ten-mile intervals along this trail system. Two experimental units, both in Banff National Park, have already been built, one located at Bryant Creek and the other at Egypt Lake. Users are enthusiastic about such units but garbage accumulation and intense depletion of firewood are already creating problems. Difficulties such as these, which can markedly disturb local animal populations and vegetation should be conceptualized beforehand, and only if they can be solved and an adequate budget exists for their solution should development proceed.

There are many shortcomings of the provisional master plans, but hope must be found in the government's already demonstrated willingness to listen to the public. At recent hearings concerning Kejimkujik National Park in Nova Scotia, public outcry over a proposed cirle road around Kejimkujik Lake, a unique natural feature of this park, caused government officials to withdraw this road from the master plan. Can conservationists hope for an entire new conceptualization and interpretation of the role which relatively undisturbed nature should play in the Rocky Mountain national parks, or must we settle for not building road X in exchange for building road YZ?

A look at the backgrounds of the present high-ranking officials within the National and Historic Parks Branch shows a striking lack of persons with ecological or parks training. Instead we find a preponderance of commerce graduates, engineers, ex-military officers, and men of similar backgrounds. Whatever their administrative and other capabilities one cannot expect that they would have the values and sensitivities necessary to manage the national parks.

The point of view of the person concerned with the integrity of nature in these parks has already been made available to the Parks Branch in the form of comments from the Canadian Wildlife Service (in a paper titled "Some Ecological Considerations Relating to the Provisional Master Plans for the Western Parks," dated April, 1969). There is little indication in the master plans that the cautions and concerns of the government's trained professional biologists and ecologists employed by the Canadian Wildlife Service were ever heeded.

Two very important ideas are given lip service in the master plans but there is little indication of serious intent to implement these ideas. Mention is made of the importance of regional planning to serve recreational needs. This need is made evident by the fast-growing city of Calgary, now near a population mark of 400,000, projected to have almost 800,000 inhabitants by 1986. Calgary, only 70 miles from Banff National Park, places much of its

Rocky Mountain Bighorn Sheep on Palliser Range, Banff National Park.

Tasteful human artifacts. Handcarved trail signs at Bryant Creek warden cabin, Banff National Park.

recreational emphasis on Banff National Park, and Banff thus has pressure to become regional rather than truly national in character. Integrated planning with the cooperation of the provinces of British Columbia and Alberta could place all facilities-oriented recreation developments outside of national park boundaries and could locate service centres in towns such as Golden, Canmore, Hinton, and Radium, these being in close proximity (respectively) to Yoho, Banff, Jasper, and Kootenay National Parks. In provincial areas outside the parks there is space and need for downhill ski areas, ski-doo areas, motor boat areas, and highly and moderately-priced lodging facilities. The parks are for the people but the natural

features that are the living core of these parks must not be sacrificed so that John Q. Public can drive into a unique ecosystem only to discover with thousands of other visitors that nature has fled. Natural beauty must be caressed, confrontation en masse often destroys the fragile and effable quality most sought after.

The second important idea which is given lip service in the master plans is the role that the parks must play in outdoor education. We know that the value derived from the natural features of any park depends upon the background of the human user of the park. Studies have shown a high positive correlation between extent of education, socio-economic status, and wilderness use and appreciation. The modern urban dweller is ill-equipped to understand the natural events portrayed and taking place in the parks. Urban man must be guided and encouraged to appreciate the very nature which originally was his source. Many teenagers from Calgary come to Banff National Park on weekends only to race their "hot rods" along Banff Avenue. They don't know what else to do. This tragedy can be avoided through intensive outdoor education programmes. To compare the relative importance given to downhill skiing versus outdoor education, the budget for Banff National Park very recently included almost a quarter of a million dollars to upgrade an access road to Sunshine Village ski area and only a very small fraction of this for interpretive services. A significant proportion of each park's budget must go toward outdoor education.

The master plans throughout reflect a gross lack of creative vision and rapport with nature. Straightline demand projections are taken to define future use patterns, which no doubt will become self-fulfilling prophesies. As use increases markedly, the introduction of more roads and facilities are thus automatically justified. Nowhere is consideration given to alternative means of transportation such as monorail or subways. Nowhere is it suggested that nature rather than the automobile and man should remain the dominant feature of the parks.

The need for research to understand park ecosystems is recognized yet development is proposed *before* study. If a proposed road is built up the Cacade Valley and thence down the Pipestone Valley in Banff National Park what will be the impact on the significant ungulate populations there? This same area offers the best grizzly bear habitat and highest population densities of this species found in the park — will the grizzly, an animal known to need wilderness, tolerate this encroachment or will he move on? The grizzly and the wolf, the living symbols of the wilderness, are each threatened by roads and developments too numerous to detail here. What research that has been available from the Canadian Wildlife Service has suggested the dangers of the proposed developments, both these dangers have not been heeded in the master plans.

The master plans are available for only two dollars by writing to the National and Historic Parks Branch of the Department of Indian Affairs and Northern Development, Western Regional Office, Customs Building, Calgary, Alberta. Each of you who is concerned about the future of the Rocky Mountain National Parks should obtain a copy and after considering them express your views to the National and Historic Parks Branch. Public hearings are scheduled in Calagry April 19-20, Edmonton 22-23, and Vancouver April 26th. At these hearings briefs will be accepted in written and/or oral form.

The Parks Branch has gone on record as saying that the plans represent an attempt to compromise the extreme views voiced on the one hand by purists and conservationists and on the other hand by facility-oriented developers. This goal might seem reasonable if Canada's national parks were not intended to be "living museums of nature — preserved for all generations".

Recent Information Concerning the Proposed Development at Lake Louise

Page 11 of the document titled *Banff National Park Provisional Master Plan* states that "a second (visitor service centre) is being developed at Lake Louise to provide year-round visitor services with over a thousand units of accommodation and the necessary retail outlets."

This rather vague statement has been given content by comments recently released, not by the Parks Branch, but by members of the Village of Lake Louise Corporation. One Village Lake Louise official stated at a Calgary meeting of the Alpine Club of Canada that the number of beds available would be "about 4,500." Additionally, he said that expansion of ski facilities was contemplated which might include lifts on the now undeveloped Red Deer River drainage. The actual location on the proposed village will occupy not only the lower valley as was previously proposed but as well is suggested to occupy a bench above the valley floor.

What will the new development be like? Outsiders can only guess. There now remains little doubt that developers want it to be done on a significant scale. The well-known architectural firm of Erikson and Massey have done the design. Several Village Lake Louise officials stated that the development will "greatly enhance the area." Can even the best architecture provide for use without impairment when a town of this size (schools, a medical unit, boutique, and other shops have been mentioned) is present inside a national park? Is a town necessary to utilize the downhill ski facilities when the townsite of Banff is only 35 miles away? Will not a development of this scope be under tremendous pressure for even greater expansion and road access with future population increases?

Last fall, because of present inadequate garbage disposal facilities, 23 grizzly bears were observed to visit the dump at Lake Louise during a six-hour period. A Village Lake Louise official when questioned on the problem of human contact with this species said "Frankly, I couldn't care less if 23 grizzlies disappear from Lake Louise."

The Parks Branch has offered this recent information. Presently, the Village Lake Louise Corporation has a letter of intent that the federal government will not negotiate with anyone else concerning the development. A plan is now being submitted by the corporation and if considered satisfactory then a lease will be granted and a licence of occupation given.

When does public comment come in? First, the Parks Branch states that the concept of a service centre is in the master plan so comment is appropriate at the master plan hearings. But comment on what? A modest visitor service centre as originally proposed? Or on a complete and large alpine village? The secrecy which has veiled this proposal negates the purpose of the public hearings. The Parks Branch further states that the plan will be presented to the public shortly *after* the public hearings on the master plans. Recent information is that this presentation will not take the form of public hearings.

Ecological Interaction of Brown Trout, *Salmo trutta* L., and Brook Trout, *Salvelinus fontinalis* (Mitchill), in a Stream

O. L. NYMAN[1]
Fisheries Research Board of Canada
Biological Station, St. John's, Newfoundland

Abstract. The present paper is meant to analyse some of the ecological factors involved in the sympatric occurrence of brown trout and brook trout in a stream in southeastern Newfoundland.

Brook trout were found in the least favourable niches in the pools or in areas of shallow rapids. No sea-run brook trout were encountered, possibly as a result of selection against alleles determining downstream migration. The brook trout population, which was only found in part of the river is probably maintained by involuntary stocking from small tributaries, which are inaccessible to ascending fish. Downstream from the area of sympatry, brook trout are absent possibly because of heavy pollution and upstream (in the absence of restocking from brooks) because of domination and predation by brown trout and differential catchability by anglers.

No food segregation between the two species was apparent in the area of sympatric occurrence, which should favour the larger and sometimes piscivorous brown trout. Food selectivity was low for both species and no species specific trends could be detected. Samples of stomach contents from areas where the species were allopatric displayed that food composition varies obviously with the relative abundance of the food objects.

Introduction

It is a well-documented fact that food (and to a certain extent spatial) segregation is a major factor for maintaining sympatric occurrence of lacustrine populations of different species of salmonid fish (e.g. Nilsson, 1963). This is also true for the interaction of brook trout and brown trout, where the latter species has been introduced, but the segregation patterns of these two species differ from those of naturally occurring sympatric brown trout and char. When co-existing in lakes, brown trout are predominantly found in the deeper areas and the brook trout occupying shallow water (Liew, 1969) whereas when found sympatrically with char, brown trout tend to favour the shallow parts of the lake (Nilsson, 1955; Gustafson et al., 1969). This co-existence of brown trout and brook trout is however disrupted in running water, sometimes with complete exclusion of the brook trout (reviewed by Nelson, 1965). This phenomenon is quite apparent on the Avalon Peninsula in southeastern Newfoundland where brown trout were introduced as early as 1884 (Scott and Crossman, 1964). Although the first introductions were made in lakes, sea-run populations were soon established, and nowadays the brown trout has extended its range to include numerous water-systems in southeastern Newfoundland, in running water almost completely displacing the native brook trout.

The ecological demands of brook trout and brown trout are almost identical. Both belong to the fauna of wet temperate regions of the northern hemisphere, their ability to withstand high and low temperatures is identical, temperature preference and upper incipient lethal temperatures are the same for both (McCrimmon and Marshall, 1968; McCrimmon and Campbell, 1969). Feeding habits, habitat preference and spawning time are also exceedingly similar. One difference, however, is the faster growth rate during the first years and thus faster attainment of sexual maturity in the brook trout.

The faster early growth coupled with the probably more aggressive behaviour of the fry may possibly account for the superiority of the brook trout in small brooks (Kjellberg, 1969). The similarity in ecology may result in hybridization, usually in rivers which are big enough to offer possibilities for habitat segregation, but small enough to force the fish to spawn in limited areas. One such hybrid, a so-called "tiger trout", was reported from the Waterford River

[1]Institute of Freshwater Research,
170 11 Drottningholm, Sweden

FIGURE 1. Location of the various sampling stations.

drainage, the first of its kind reported in Newfoundland (Nyman, Peet and Wiseman, unpublished). Waterford River, which discharges its water in the westernmost part of the heavily polluted harbour of St. John's, Newfoundland, is one of the very few rivers where brown trout and brook trout still co-exist in the general area where brown trout were first released in Newfoundland. All other rivers and large brooks around the capital city are inhabited exclusively with brown trout, which is also the dominating salmonid in most lakes of the region. It was the main objective of this investigation to determine the reason for this sympatric occurrence.

Materials and Methods

All fish analysed in this study were caught by angling using a flyrod/spinning line combination, Small (No. 12) hooks and live worms for bait. The line was light green and had a diameter of .22 mm. In addition fry were caught by hand in a couple of small tributaries of Waterford River for species classification purposes. Stomach contents analysis was performed on fish from four river systems, Rennie's (Stations 1A, 1B) containing only brown trout (and eels), Big Barachois (Station 2) and Shores Cove (Station 3) exclusively brook trout, and Waterford (Station 4) having sympatric populations of both species (and eels) (Figure 1). The percentage distribution of the various food items was calculated from the wet volume of fresh stomach contents as approximated from simple volumetric estimations.

To illustrate the feeding habits of the fish, the radial diagram described by Nilsson (1957) was used. The mean percentages per species per sampling period were plotted ". . . in a radial diagram, where the perimeter represents 25 percent and the points are bound together to display a characteristic figure." Thus, the radius represents 25% of the wet volume of food (see Figures 2 and 3). The various food items found were placed in the diagram in the following order (also according to Nilsson, 1957):

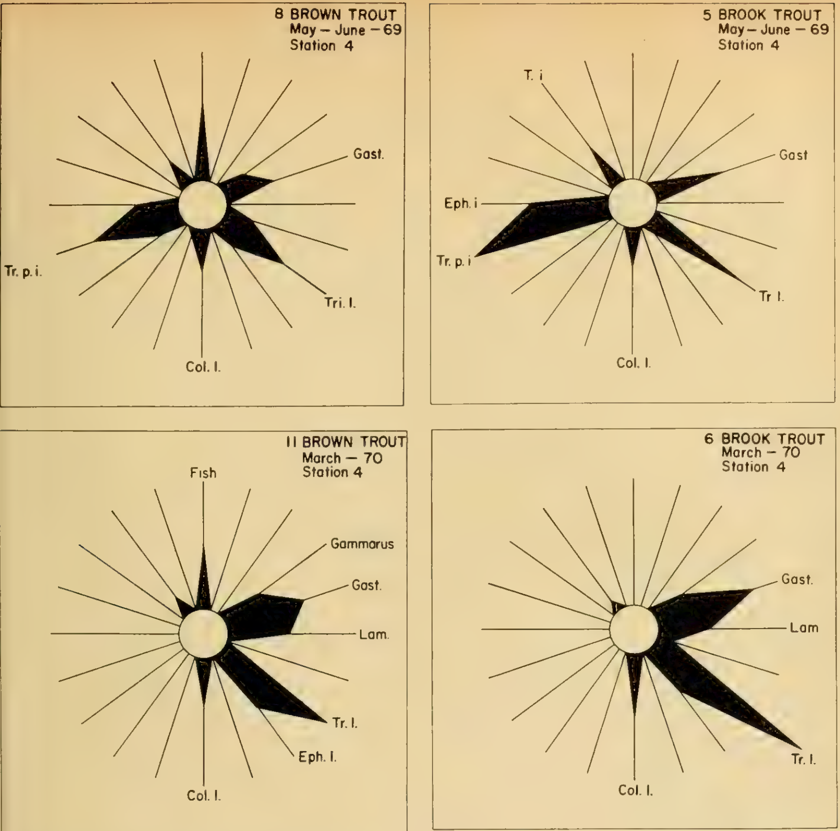
(1) Vertebrates
(2) Planktonic crustaceans
(3) Semi-planktonic crustaceans
(4) Benthic crustaceans
(5) Gastropoda
(6) Lamellibranchiata
(7) Other obligatory bottom animals
(8) Trichoptera larvae
(9) Ephemeroptera larvae
(10) Plecoptera larvae
(11) Aquatic Coleoptera larvae
(12) Chironomidae larvae
(13) Simuliidae larvae
(14) Tipulidae larvae
(15) Trichoptera pupae and imagines
(16) Ephemeroptera, Plecoptera and Megaloptera imagines
(17) Chironomidae and Simuliidae pupae and imagines
(18) Tipulidae imagines
(19) Terrestrial insects
(20) Miscellaneous

Only food of animal origin was considered in the diagram, debris of varying size (gravel and plant remnants) however, were quite common, and in a few cases, especially among brown trout, made up over half the stomach contents.

Results and Discussion

Sympatric occurrence of brown trout and brook trout

In Waterford River there is a well established population of sea-run brown trout which sup-



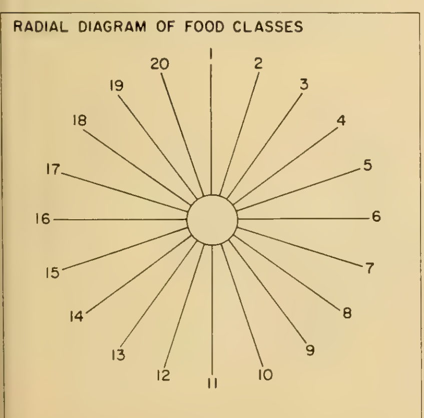


FIGURE 2. The feeding patterns of brown trout and brook trout in Waterford River. Date of catch and number of trout analysed for stomach contents are shown.

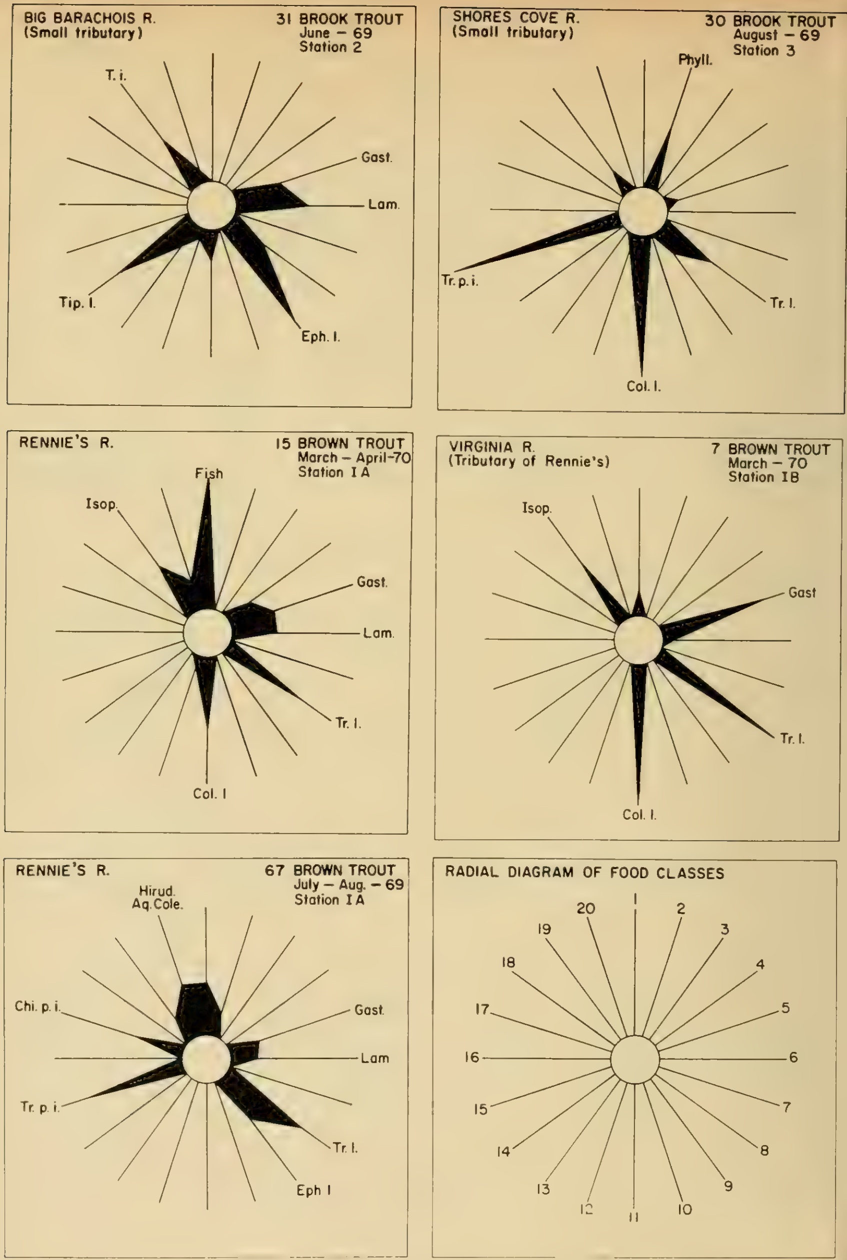


FIGURE 3. Feeding patterns of allopatric populations of brown trout and brook trout. Date and location of catch and number of trout analysed for stomach contents are shown.

plements the few resident browns, but so far I have not found any evidence for a run of sea-migrating brook trout. Waterford River is a small (drainage basin 23.5 square miles, axial length 8.4 miles), rather fast-flowing river, and there is thus little possibility for habitat segregation in the pools. Using the mentioned fishing methods, a wide range of size of fish should be attracted, worms being the most effective bait for both species. The greater resistance to angling by brown trout may possibly tend to underestimate the proportion of this species in the river, but I have more than twenty years experience of brown trout fishing as contrasted to no experience at all in fishing brook trout, and this might keep the difference in catchability at a negligible level.

When fishing a pool by allowing the bait to flow freely into it with the current a typical catch pattern could be seen. In a rather deep pool fish caught in marginal areas and in the upper water layers were all small brown trout. When the marginal areas of a pool was empty of browns, brook trout could be caught. These brook trout were on the average smaller than the brown trout and exhibited a wider size range. The deeper parts of the pools which could only be fished by employing a sinker, were the typical niches where the big sea-run brown trout dominated. When these sea-run fish were removed they were replaced by smaller brown trout, hardly ever with brook trout. In shallow parts of the river where long exposed pools alternate with shallow rapids, no sea-run fish were encountered and the brook trout were confined almost exclusively to the shallow, swift-flowing rapids.

Stream-dwelling salmonids are strongly territorial in behaviour and this limits the production of any stream since the size of the territories determines the maximum numerical density which it can support (Allen, 1969). Since the size of the territories is more or less directly proportional to the weight of the fish and the brown trout on the average are larger than brook trout (in Waterford River) brook trout are more likely to be displaced in the competition for space. In agreement with this the remaining brook trout are found in the least favourable pools (as far as cover is concerned) where they are also more vulnerable to predation by the piscivorous brown trout.

One of the reasons why there are so relatively few freshwater brown trout in this river may be due to the fact that kills occur quite frequently as the result of pollution. On November 15, 1965, an oil slick eradicated the fish in the lower reaches of the river which were within the area of the recent investigation. An investigation by fishery biologists of the Resource Development Branch, Department of Fisheries and Forestry, St. John's, showed that only 6% of the fish were brook trout and that most of the brown trout were large fish (1-2 lb) (Peet, personal communication). Such occasional polluting agents of course adversely affect the bottom fauna as well and may act as an important limiting factor on the number of non-migratory fish. These fluctuations of the biotope may be one of the reasons why sea-run fish predominate, since they are not equally dependent on a permanent food supply as the resident fish. Also, Elton (1958) noted that invading species (brown trout) are most likely to become dominant in unstable environments and Nelson (1965) found that brown trout are well adapted to fluctuating rivers.

It might seem that a brook trout proportion of only 6% must be close to the minimum size for a self-sustaining population and the question is why they did not become extinct in the possibly 70-odd years that brown trout had existed in the river, especially so in light of the occasional kills that must have wiped out almost the entire population with no sea-migrating fish that could restock the river when conditions had improved. I came across the probable answer more or less by accident. In order to find out whether any fish existed in the small tributaries of the north shore of the river, it was found that in pools of these brooks, which are hardly more than a trickle in water-flow, there existed populations of dwarfed brook trout. The lower reaches of these brooks fall rapidly through densely populated areas in the western suburbs and the falls as well as steep culverts and extensive pollution may prove a complete barrier to ascending fish. These tiny brooks may

thus never have been inhabited by brown trout, or else brook trout may prove superior in small brooks, as has been suggested when brook trout have been released in waters where brown trout is the native salmonid (Kjellberg, 1969). In any case these brooks may help sustain a certain proportion of brook trout in the main river as a result of more or less fortuitous downstream movement caused by catastrophies such as sudden floods, the low proportion depending on a strong selection against alleles determining downstream and thus sea-migration. Such a mechanism would prevent extinction of the brook trout in the brooks and would closely resemble the case with the non-migratory brown trout which exist upstream of a falls on the river Verkeån in southern Sweden (Svärdson, 1964). This selection would also explain why there are no sea-run brook trout in this river, although such populations are found in most streams outside the brown trout dominated streams. The brook trout of the main river are confined to a rather limited area comprising roughly 1 mile of the river, downstream probably limited by extensive pollution (which seems to affect brown trout to a lesser degree), upstream by complete brown trout domination. In the upper parts of the river where brown trout was the only species, no 'brook-trout-producing' brooks could be found, but brook trout and brown trout are again sympatric in the small lakes of this region.

The major tributary of Waterford River, South Brook, is only accessible to ascending fish for half a mile where a series of falls forms a complete obstruction. Since no fish-producing brooks are found downstream from these falls, the presence of brook trout is maintained either by restocking from the main river, or by downstream migration of fish from above the falls.

What seems to have happened after the kill of 1965 is a period of restocking of brook trout from the small tributaries. These fish thus could spread without any resident brown trout competing for the same food objects and the same habitats. Also, when the sea-run brown trout returned to spawn they were large fish utilizing food objects bigger than those of importance for the young brook trout and they favoured only the deepest parts of the deep pools, leaving maybe a year for the brook trout to spread and occupy the best niches. The following spring when the brown trout fry hatched, the aggressive behaviour of the brook trout fry would be an advantage and possibly partially delay the return of the resident and sea-run brown trout fry. This condition may very soon change and young brown trout are found to select the most favourable territories and successfully defend them from intruders (e.g. Kalleberg, 1958; Nelson, 1965). With the growth of the brown trout this advantage of the brook trout would thus diminish and at last the brook trout proportion would be down again at the level maintained by involuntary restocking from the tributaries. It is difficult to predict the time span that this drop to the 6% level would require since we do not know what type of curve this decrease will follow, but the 1969-70 catch, although small, shows a proportion of 32% brook trout. Another condition which would accelerate the exclusion of the brook trout is the differential catchability by anglers of the two species, brown trout being far more difficult to catch (reviewed by Miller, 1957). The reason for the difference in catchability has been attributed to superior intelligence in the brown trout (Adelman and Bingham, 1956) which may have developed through selection by angling over thousands of years producing a more intelligent and more wary trout (Miller, 1957). This continuous selection for wariness may explain why fishing grows progressively less successful over the years and ". . . is at least a better assumption than the angler's, i.e. that the populations have been seriously depleted; this explanation has frequently been disproven." (Miller, 1957). Also, the low catchability of brown trout may probably be partially due to the strong cover-seeking reactions found in this species.

Food segregation

The other problem was to estimate the degree of food segregation that would exist in such a spatially limited environment. Although confined to marginal areas of the pools of

Waterford River, brook trout feed on the same food items as the brown trout of the same pools. This lack of food segregation, which strongly contrasts the condition found among sympatric species of lake-dwelling salmonids (Nilsson, 1960, 1963) is equally apparent in March as in May-June (Figure 2). Trichopteran and ephemeropteran larvae make up from ⅓ to ½ of the food for both species in March, with other benthic organisms such as crustaceans and mollusks making up most of the remainder. Aquatic coleoptera larvae are also abundant in the stomachs of both species and some fish had been feeding on terrestrian isopods which exist in enormous quantities in this damp climate. One difference was however apparent in that some brown trout had been feeding on fish, which could not be identified to species. Brook trout were never observed to be piscivorous. In May-June trichopteran larvae were still important food items, but far more important were the pupae and imagines of the same insects. Mollusks had dropped in importance, but snails of the family Amnicolidae were still abundant in the stomachs. Terrestrial insects are only rarely seen and are mostly adult trichopterans, dipterans hardly ever found in the form of adults. Even in the summer there is a striking similarity in the feeding habits of the two species, and from the small number of fish here investigated no apparent food segregation could be detected. Food preference appears insignificant for both species, although of course bigger fish eat slightly bigger food items. Because only a very small number of pools within a limited area of the river were sampled nothing is known about differences in relative abundance of food items, and thus in food preference, in other parts of the river.

In order to see how wide the range of potential food objects could be, and if any species specific trends could be detected, samples were also obtained from other localities on the Avalon Peninsula where the species were allopatric. Station 2, which was sampled in June displayed the same importance of trichopteran larvae as the summer samples from Waterford River (Figure 3). This station was a beaver-dammed gully of a small brook and brook trout were the only species of fish. An obvious difference from Waterford River, however, was that terrestrial insects and dipteran larvae were very abundant food items. The mollusk fauna was however similar. Station 3 was again completely different from the other samples in that larvae of aquatic coleopterans were numerous, and because of the time of the year (August) trichopteran pupae and imagines as well as *Daphnia* formed the bulk of the organic drift. Mollusks were very scarce in this habitat.

The samples from Rennie's River (drainage basin 19.6 square miles, axial length 7.0 miles) are quite similar to the stomach contents of brown trout from nearby Waterford River. The most striking difference between the samples is the presence of adult aquatic Coleoptera and Hirudinae (Station 1A). Also, mollusks seem to be less important on this biotope. These lacustrine elements probably emanate from Long Pond, upstream from the sampling stations. Even in winter (March) the feeding habits of the brown trout of Rennie's River are similar to those of Waterford River, but fish and terrestrial isopods account for an even greater share. The small sample from Station 1B, however, although a tributary of Rennie's River is strikingly different. Here the percentage of fish in the diet has dropped and four food items are of equal importance, viz., aquatic Coleoptera larvae, Trichoptera larvae, Amnicolidae snails and terrestrial isopods.

The above summary of the feeding habits of the two species support the view that food selectivity is low in brook trout and brown trout. Both species are indiscriminate carnivores (e.g. Frost, 1940; Nilsson, 1957; Vladykov, 1957; Wiseman, 1969), which means that a wide variety of food objects are utilized and thus should facilitate food segregation, at least in lacustrine environments where it may be coupled with habitat segregation as well. In the limited bodies of water of small rivers, however, habitat segregation is difficult to maintain and, because of the similar ecological demands of the two species, leads to the exclusion of one of them, in this case the brook trout.

Acknowledgments

Thanks are due to Mr. Roger Peet, Department of Fisheries and Forestry, St. John's, for bringing the results of the fish kill to my attention and for stimulating discussions, and also to Mr. Leslie Dominy, Resource Development Branch, Halifax, for invaluable information on pertinent references.

Literature Cited

Adelman, H. M., and **J. L. Bingham.** 1956. Size discrimination in the brook, brown and rainbow trout. Progressive Fish-Culturist 18(1): 26-29.

Allen, K. R. 1969. Limitations on production in salmonid populations in streams. *In* H. R. MacMillan lectures in fisheries, Symposium on Salmon and Trout in Streams 1968, 3-18.

Elton, C. S. 1958. The ecology of invasions by animals and plants. Methen & Co., Ltd. 181 p.

Frost, N. 1940. A preliminary study of Newfoundland trout. Newfoundland Department of Natural Resources, Research Bulletin 9: 30 p.

Gustafson, K.-J., T. Lindström, and **A. Fagerström.** 1969. Distribution of trout and char within a small Swedish high mountain lake. Report Institute of Freshwater Research, Drottningholm 49: 63-75.

Kalleberg, H. 1958. Observations in a stream tank of territoriality and competition in juvenile salmon and trout (*Salmo salar* L. and *Salmo trutta* L.). Report Institute of Freshwater Research, Drottningholm 39: 55-98.

Kjellberg, G. 1969. Några data om bäckrödingen. Inform.fr. Sötvattenslab., Drottningholm 4: 6 p.

Liew, P. K. L. 1969. A study of the biology of brown trout, *Salmo trutta* Linn., from four different habitats on the Avalon Peninsula, Newfoundland. M.Sc. thesis at Memorial University of Newfoundland, 186 p.

McCrimmon, H. R., and **J. S. Campbell.** 1969. Work distribution of brook trout, *Salvelinus fontinalis*. Journal of the Fisheries Research Board of Canada 26: 1699-1725.

McCrimmon, H. R., and **T. L. Marshall.** 1968. World distribution of brown trout, *Salmo trutta*. Journal of the Fisheries Research Board of Canada 25: 2527-2548.

Miller, R. B. 1957. Have the genetic patterns of fishes been altered by introductions or by selective fishing? Journal of the Fisheries Research Board of Canada 14: 797-806.

Nelson, J. S. 1965. Effects of fish introductions and hydroelectric development on fishes in the Kananaskis River system, Alberta. Journal of the Fisheries Research Board of Canada 22: 721-753.

Nilsson, N.-A. 1955. Studies on the feeding habits of trout and char in North Swedish lakes. Report Institute of Freshwater Research, Drottningholm 36: 163-225.

————. 1957. On the feeding habits of trout in a stream of Northern Sweden. Report Institute of Freshwater Research, Drottningholm 38: 154-166.

————. 1960. Seasonal fluctuations in the food segregation of trout, char and whitefish in 14 North-Swedish lakes. Report Institute of Freshwater Research, Drottningholm 41: 185-205.

————. 1963. Interaction between trout and char in Scandinavia. Transactions of the American Fisheries Society 92(3): 276-285.

Scott, W. B., and **E. J. Crossman.** 1964. Fishes occurring in the fresh waters of insular Newfoundland. Queen's Printer, Ottawa, 124 p.

Svärdson, G. 1964. Verkeåns öring. *In* Svärdson and Nilsson. Fiskebiologi. Hallandspostens Boktryckeri, Halmstad, 253 p.

Vladykov, V. D. 1957. Speckled trout. Fishes of Quebec, Album No. 1, Department of Fisheries, Quebec, P.Q., 8 p.

Wiseman, R. J. 1969. Some aspects of the biology of the speckled trout, *Salvelinus fontinalis* (Mitchill) 1815, in the waters of insular Newfoundland. M.Sc. thesis, Memorial University of Newfoundland, 381 p.

Received July 2, 1970
Accepted September 6, 1970

Geographical Variation in the Eggshells of Common Loons

DANIEL W. ANDERSON
Department of Wildlife Ecology, University of Wisconsin, Madison, Wisconsin 53706.

HARRY G. LUMSDEN
Ontario Department of Lands and Forests, Research Branch, Maple, Ontario.

JOSEPH J. HICKEY
Department of Wildlife Ecology, University of Wisconsin, Madison, Wisconsin 53706.

Abstract. Common Loon (*Gavia immer*) eggshells from various museums throughout North America were measured. Geographical variation in the (1) empty eggshell weight, (2) length, (3) breadth, (4) length-breadth ratio, (5) volume, and (6) eggshell thickness including membrane, is described. Comparisons among seven geographical areas with subjectively established boundaries were made. They included the breeding range of Common Loons extending from Iceland to Alaska. These geographical areas were (1) Alaska and British Columbia (2) Washington, Idaho and Montana, (3) Alberta, Saskatchewan and Manitoba, (4) Minnesota, Michigan and Wisconsin, (5) Ontario and Quebec, (6) Maine, New Hampshire, New York, Nova Scotia, Labrador and Newfoundland, and (7) Iceland.

Variation in egg size occurs according to the trends in body size using wing chord as an index.

Two or more general latitudinal continuums probably best describe the data, possibly one on each side of Hudson Bay. The clines do not seem related to latitude on a strictly quantitative basis. The interior regions seem to show less variation with the same amount of latitude than peripheral regions.

Clutch-size variation by area is difficult to interpret because of lack of information on bias by some collectors who may have rejected single-egg clutches. There seems to be little difference between areas in mean clutch size except for Ontario and Quebec where clutches may be smaller.

Introduction

Our major objective here is to report geographical variations in the eggshells of Common Loons (*Gavia immer*). The data, besides being of interest from an academic viewpoint, have a potential practical application. Numerous authors have recently reported eggshell changes, namely in shell thickness and weight, in certain bird species. These findings dictated, but not necessarily so, that our cutoff date in anlysis of "normal" geographic variation be no later than 1946 (see Ratcliffe 1967, and Hickey and Anderson 1968).

Indices to Geographical Variation

Rand (1947) has used two criteria to report geographical variation in the Common Loon, bill length and wing length, the latter being more, but not entirely satisfactory. The wing-chord measurements of Rand (1947), although somewhat variable, were adequate to suggest geographic variation in size on an intraspecific basis in North American Common Loons. Despite potential weakness in the use of wing chord as an index to body size (see Welty 1964: 457-58 and Scholander 1955), it seems generally satisfactory (Mayr 1956 and Amadon 1943*a*), especially on an intraspecific basis. Since many readily taken eggshell measurements (such as volume, thickness and weight) often seem to relate to body size on an intra- and even sometimes on an interspecific basis (Romanoff and Romanoff 1949:150, Amadon 1943*b*, Lack 1968: 235, Anderson and Hickey 1970), most of our measurements here probably reflect body size. The general relationship between wing chord and body size reported by Rand (1947), then, provided us with a basic hypothesis to test statistically, applying our eggshell data to an already hypothesized trend.

Materials and Methods

Eggshells were measured from various museums throughout North America as already described by Anderson and Hickey (1970). The basic variables we examined were as fol-

lows: empty-eggshell weight including membranes, egg length (L), egg breadth (B) at its widest portion, L/B ratio, estimated outside volume and eggshell thickness including membranes and cuticle. Tyler (1969) has described in detail the shell structure of Gaviiformes and it is obvious that our measurements of thickness encompassed many various structures. Amadon (1943*b*) described various methods used to obtain measurements relating to egg volume. We estimated volume on the basis of the shape categories described by Preston (1953) and Palmer (1962: 13) and the constant LB^2 as discussed by Amadon (1943*b*). Examples (10 to 11 each) of the two shape categories we found in loons, subelliptical and oval, were immersed in water for a volumetric determination of outside volume. Cylinder volumes with equivalent L and B measurements of each egg were calculated and a correction factor (CF) for each shape determined. We originally planned to calculate a CF-regression formula for differing L/B ratios within each shape category, but found them to be remarkably agreeable within the ranges we tested, and therefore combined them. The resultant CF's were as follows: subelliptical = 0.64, oval = 0.62. We multiplied these by the volume of a cylinder of equal L and B for each egg to obtain our estimate of volume. This procedure is essentially similiar to that described by Stonehouse (1963). The hypothesis which we tested is restated as follows: (1) geographic variation in eggshells occurs in North American Common Loons, and (2) it occurs according to the trends (wing chord as an index to body size) described by Rand (1947). Statistical tests were (1) analysis of variance, and (2) Duncan's new multiple-range test (Steel and Torrie 1960: 112-15, 107-09). The hypothesized trends are summarized in Fig. 1 as we vision them from Rand's descriptions.

FIGURE 1. Map showing trends in the wing-chord measurements of Common Loons as described by Rand (1947)—dotted line. The breeding range of *Gavia immer* is adapted from Palmer (1962:27) and Godfrey (1966:10) with modification from the AOU Check-list (1957) concerning California. Circles indicate, subjectively, relative differences in wing chord, and arrows point to increases in the trend. Solid lines enclosing geographical regions represent subjective groupings as we would see them for statistical testing and as best fitting our sample distributions. Eggshells from area 5 represented inland nests, and Ontario eggs from the Great Lakes were included in area 4. Areas of especially noticeable overlap in measurements, according to Rand (1947), are between 5 and 6 and between 1 and 3.

Results and Discussion

Eggshell Measurements

All six variables tested showed highly significant differences ($P < 0.01$) between our various subjective groupings used to test for clinical variation (Table 1). The *F*-test generally confirms Rand's (1947) description of variation in Common Loons. The Duncan's-test, although not entirely satisfactory because of its one-dimensional character, yielded additional information regarding a description of the variation (Table 2). Volume comparisons (Table 2), for example, gave 12 significant differences in 21 tests, whereas only 1-2 would be expected at the 95% level due to sampling error. Eggshell weight, volume and thickness generally followed similar trends which were much alike and in accordance with previously described trends. Since eggshell weight, volume and thickness are generally interrelated parameters on an intraspecific basis (Asmundson

TABLE 1. — Analyses of variance, comparing six eggshell variables in Common Loons over seven geographical areas

Variable name	Degrees of Freedom:		F–value[1]
	Among	Within	
Eggshell wt. (g)	6	295	20.44
Length (cm)	6	295	7.77
Breadth (cm)	6	295	22.86
Length/Breadth	6	295	5.33
Volume (cm³)	6	295	23.31
Thickness (mm)	6	239	7.15

[1] F–values at various significance levels are as follows (Steel and Torrie 1960:440): $P.05 = 2.10$, $P.01 = 2.80$.

and Baker 1940, and Asmundson et al. 1943), similar trends are to be expected. The general uniqueness of middle groups (geographical areas 2, 3 and 4, Fig. 1) with significant differences moving out in both directions from those areas, suggests a linear, but branching variation either converging or diverging from that area, possibly related to latitude and Bergmann's Rule. Even though, in all cases, the values on each end of the spectrum were not significant statistically from one another on a ranked basis, we believe them to be biologically significant due to their geographical separation. Perhaps two statistical tests would have illustrated the data better, using these interior areas as a "starting point" for each. The patterns observed with weight, volume and thickness seemed nearly opposite to those observed with L/B ratios, but by no means were the differences large or of sufficient magnitude to yield noticeable differences except from the interior areas (5 and 6) out toward each extreme. The large F-value for breadth as compared to length (Table 1) suggests that B is the most variable. Somewhat different L/B ratios, in any case, suggested possible differences in the shape distributions from area to area. We tested this hypothesis with Chi^2 and found that significant differences occurred in a pattern generally similar to that observed for differences in the L/B ratios. Areas 5 and 6 (Fig. 1) tended to have significantly different distributions of the two shape categories (area 5 was significantly different, $P < 0.05$, from areas 2, 3, 4 and 7; area 6 was significantly different from 3). L/B ratios (Table 2) from area 5 were not significant only from adjacent geographical areas, 3 and 6. When areas 5 and 6 were combined and tested against the remainder in a 2×2-table, it was found that their tendency toward a larger proportion of subelliptical eggs was significantly different ($P < 0.01$, $Chi^2 = 21.3$). The mean ratio of subelliptical/oval in areas 5 and 6 was 0.56 as compared to 1.74 in the remainder of the areas.

TABLE 2. — Geographic variation in four eggshell variables of Common Loons from seven geographical areas

Geographical area[1]	Sample size[2]	Variable Mean ± 95% Confidence Limits and Differences:[3]							
		Weight	Test	L/B	Test	Volume	Test	Thickness	Test
1	32 (24)	16.8±0.5	ABC	1.54±0.04	E	143.7±3.5	BC	0.64±0.01	ABC
2	10 (9)	15.5±1.4	DEF	1.58±0.04	BCDE	130.9±8.7	F	0.63±0.04	BCDE
3	70 (42)	14.3±0.3	F	1.60±0.02	AB	128.0±2.4	F	0.60±0.01	EF
4	49 (39)	15.6±0.4	DE	1.58±0.03	BCD	140.5±3.3	CDE	0.61±0.02	EF
5	69 (60)	16.1±0.5	BCD	1.62±0.02	A	142.7±3.0	BCDE	0.63±0.01	BCD
6	38 (38)	17.1±0.5	AB	1.61±0.03	ABC	146.3±2.9	AB	0.65±0.01	AB
7	34 (34)	17.4±0.7	A	1.56±0.02	DE	150.3±4.0	A	0.66±0.02	A

[1]Areas are numbered in accordance with Fig. 1 with sample locations as follows: 1 = Aka., B.C.; 2 = Wash., Ida., Mont.; 3 = Alta., Man.; 4 = Minn., Mich., Wisc., Ont.; 5 = Ont., southern Que.; 6 = Me., N.H., N.Y., N.S., Lab., Nfld.; 7 = Iceland, eastern Greenland (see Palmer 1962:27 for justification in combining these).
[2]No. in parentheses is sample size for thickness only.
[3]Means not significantly different from one another share a common letter in the "test" column.

TABLE 3. — Clutch-sizes of Common Loons from various geographical areas

Geographical Area[1]	Sample size	Mean clutch-size	95% confidence limits
1+2	23	1.87	0.15
3+4	65	1.92	0.07
5	58	1.64	0.14
6	20	1.95	0.10
7	17	2.00[2]	0.00
all	183	1.84	0.06

[1]See Table 2, footnote 1.
[2]All clutches we found in museums were composed of two eggs, therefore the zero values for 95% Confidence Limits. Most of these eggs were collected by one collector, and might be biased away from single eggs.

Since areas 5 and 6 tended to have the higher L/B (Table 2; admittedly, there is a great deal of overlap, and differences are only slight), our tentative conclusion is that different tendencies in L/B ratios must at least in part be related to different shape tendencies. The loon eggs with the greatest L/B ratios were the eggs which tended more toward subelliptical and those with the smallest L/B ratios tended more toward oval.

Clutch-size

Much discussion has been presented regarding geographical variation in clutch-size (see Lack 1954, 1968; Cody 1966; and others). There seemed to be little difference between the mean clutch-size between most areas, except in our samples from area 5, where differences seemed apparent ($P < 0.05$ differences from all but 1 and 2). There appears to be a rough trend for clutch-size to increase out from this area (Table 3). When areas 1 and 2, and 3 and 4 were analysized singly, no differences or even trends could be found, thus their combinations in Table 3. Unfortunately, we had no data from Greenland, Baffin Island, or Northwest Territories to test for further changes in the trend. Mean egg volume showed no relationship to clutch-size due to the variability in clutch-size. We do not know, however, if the clutch-size data were biased by failure to collect one-egg clutches in some areas. Such clutches are reportedly fairly common for *G. immer* (see Olson and Marshall 1952, and Palmer 1962: 31). We doubt that our Iceland sample, for example, truly represented the tendency for a lack of one-egg clutches from Iceland. We believe that additional data to increase sample-sizes are necessary before conclusions can be made relating clutch-size to some geographical gradient or to egg volume in loons. There is good reason to believe that these relationships exist (see Lack 1968: 233-34 and Mayr 1965: 325).

General Discussion

The data presented in this paper confirm geographic variation in various eggshell measurements of the Common Loon. The eggshell measurements which most likely relate to body size showed the same trends as described by Rand (1947) for other measurements relating to body size. Snyder (1957: 26) recognizes a "limited" correlation between size and latitude in Common Loons, but stresses that consider-

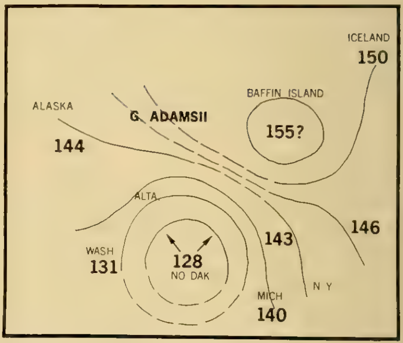


FIGURE 2. Hypothesized isophenes for eggshell volume in Common Loons, assuming that the clines as we interpret them generally cross the isophenes at right angles (Mayr 1965:362). This figure is only roughly sketched and on the same scale as Fig. 1. The values given are mean volumes from each area. The value for Baffin Island is strictly hypothetical but assumes that this deme, having the largest individuals (Rand 1947), will have the largest eggs.

able overlap occurs in intermediate areas. Todd (1963: 75) discounted any evidence of a cline in this species on the basis of bill and wing measurements, but suggested trends, nonetheless. He did not believe that smaller forms to the south should be recognized taxonomically due to a considerable overlap in measurements. This was in agreement with Rand (1947). We do not believe that the regions we tested here on a statistical basis are biologically discreet, due to the overlaps in significance between neighboring regions. Two or more general latitudinal continuums probably best describe our data on a purely subjective basis, possibly one each on each side of Hudson Bay. The clines do not seem related to latitude on a strictly quantitative basis, however. The western regions seem to show less variation with the same amount of latitude that shows greater variation in the east, especially when Baffin Island birds are theoretically considered (we did not have eggshells from this area). The isophenes (see Mayr 1965: 362) of, say, egg volume might be visioned as shown in Fig. 2. We regard the clinal variation described here for the Common Loon to be "ecotypic" as described by Mayr (1956, 1965: 415) and therefore probably of little taxonomic relevence (Mayr 1965: 363). It is interesting that in the area of proposed isolines outside the breeding range of Common Loons (dashed lines in northwestern and north-central North America, Fig. 2), another species, *G.adamsii,* breeds (Rand 1948). Palmer (1962: 35) reports that *G. adamsii* is the largest of our loons, but eggshell measurements are nearly identical, comparing the two species (Palmer 1962: 31, 40). Godfrey (1966: 11) does not believe there is sufficient justification to consider these two allopatric species as "mere races of the same species", as proposed by some authors, and it appears that eggshell measurements might help justify this conclusion in demonstrating different body-size/egg-size ratios. Studies concerning the eggshells of *G. adamsii* are needed.

Acknowledgements

This study was supported by the Bureau of Sport Fisheries and Wildlife, Patuxent Wildlife Research Center, Laurel, Maryland. Lucille F. Stickel and Eugene H. Dustman advised us throughout the study.

We wish to acknowledge Austin L. Rand and W. Earl Godfrey for critical advice. We are grateful to the many private egg-collectors and museum curators who aided us in obtaining our raw data. Keypunching and computer facilities were provided by the College of Agricultural and Life Sciences, University of Wisconsin.

Literature Cited

American Ornithologists' Union. 1957. Check-list of North American birds, fifth Edition, Baltimore, American Ornithologists' Union.

Amadon, D. 1943a. Bird weights as an aid in taxonomy. Wilson Bulletin 55: 164-177.

Amadon, D. 1943b. Bird weights and egg weights. Auk 60: 221-234.

Anderson, D. W. and **J. J. Hickey.** 1970. Oological data on egg and breeding characteristics of Brown pelicans. Wilson Bulletin 82: 14-28.

Asmundson, V. S., and **G. A. Baker.** 1940. Percentage shell as a function of shell thickness, egg volume and egg weight. Poultry Science 19: 227-232.

Asmundson, V. S., G. A. Baker, and **J. T. Emlen.** 1943. Certain relations between the parts of birds' eggs. Auk 60: 34-44.

Cody, M. L. 1966. A general theory of clutch size. Evolution 20: 174-184.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada Bulletin 203, Biological Series 73. 428 pp.

Hickey, J. J. and **D. W. Anderson.** 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science 162: 271-273.

Lack, D. 1954. The natural regulation of animal numbers. Oxford University Press, London. 343 pp.

Lack D. 1968. Ecological adaptations for breeding in birds. Methuen, London. 409 pp.

Mayr, E. 1956. Geographical character gradients and climatic adaptation. Evolution 10: 105-108.

Mayr, E. 1965. Animal species and evolution. Harvard University Press, Cambridge. 797 pp.

Olson, S. T., and **W. H. Marshall.** 1952. The Common Loon in Minnesota. University of Minnesota Museum of Natural History. Occasional Papers 5. 77 pp.

Palmer, R. S. (Editor). 1962. Handbook of North American birds. Volume 1/loons through flamingos. Yale University Press, New Haven. 567 pp.

Preston, F. W. 1953. The shapes of birds' eggs. Auk 70: 160-182.

Rand, A. L. 1947. Geographical variation in the loon, *Gavia immer* (Brunnich). Canadian Field-Naturalist 61: 193-195.

Rand, A. L. 1948. Glaciation, an isolating factor in speciation. Evolution 2: 314-321.

Ratcliffe, D. A. 1967. Decrease in eggshell weight in certain birds of prey. Nature (London) 215: 208-210.

Romanoff, A. L., and A. J. Romanoff. 1949. The avian egg. Wiley, New York. 918 pp.

Scholander, P. F. 1955. Evolution of climatic adaptation in homeotherms. Evolution 9: 15-26.

Snyder, L. L. 1957. Arctic birds of Canada. University of Toronto Press, Toronto. 310 pp.

Steel, R. G. D., and **J. H. Torrie.** 1960. Principles and procedures of statistics: with special reference to the biological sciences. McGraw-Hill, New York. 481 pp.

Stonehouse, B. 1963. Egg dimensions of some Ascension Island sea-birds. Ibis 103b: 474-479.

Todd, W. E. C. 1963. Birds of the Labrador peninsula and adjacent areas. University of Toronto Press, Toronto. 819 pp.

Tyler, C. 1969. A study of the egg shells of the Gaviiformes, Procellariiformes, Podicipitiformes and Pelecaniformes. Journal of Zoology (London) 158: 395-412.

Welty, J. C. 1964. The life of birds. W. B. Saunders, Philadelphia. 546 pp.

Received July 15, 1970
Accepted July 15, 1970

The Flora and Vegetation of Van Hauen Pass, Northwestern Ellesmere Island

GUY R. BRASSARD[1] AND R. E. LONGTON[2]

Abstract. Eighty species and one variety of vascular plants are reported from Van Hauen Pass, northwestern Ellesmere Island, and the flora and vegetation is compared with that in other northern parts of the island. *Geum rossii, Epilobium arcticum* and *Potentilla pulchella* var. *gracilicaulis* are the most notable records. Sedge meadow, as well as both wet and dry heath, are widespread at Van Hauen Pass, where parts of the lowlands are strikingly better vegetated than at inland stations farther east. However, extensive areas of sparsely vegetated clay, gravel and scree are perhaps mainly due to aridity or to solifluction.

Introduction

Botanical investigations in northern Ellesmere Island have, until comparatively recently, comprised largely floristic studies in coastal areas, notably around Alert and Eureka (Bruggemann and Calder 1953; Porsild 1964; Schuster, Steere and Thomson 1959). The establishment of a scientific station at Hazen Camp by the Defence Research Board in 1957 facilitated observations in the interior of the island (Powell 1961, 1967; Savile 1964; Soper 1959). In 1963 a second station was opened, at Tanquary Camp, and the first author spent the summer of 1964 making a general survey of the flora and vegetation near the head of Tanquary Fiord (Brassard 1967a, 1967b, 1968; Brassard and Beschel 1968).

During the summer of 1967 both present authors worked on northern Ellesmere Island. Observations were made on the growth and reproductive behaviour of widely distributed bryophytes (Longton 1969), while general floristic and ecological studies were continued at Hazen Camp and Tanquary Camp, and a preliminary survey was made at Van Hauen Pass (Fig. 1), an area in the northwestern part of the island that was previously unexplored botanically (Brassard and Longton 1969). The present paper lists the vascular plants recorded at Van Hauen Pass during late June and early July (Appendix 1), and briefly compares the flora and vegetation of this area with other parts of northern Ellesmere Island.

General Features of Van Hauen Pass

Van Hauen Pass runs through the range of hills separating Hare Fiord and Otto Fiord (81° 07′N, 85° 55′W). The distance from the former to the head of a small bay in Otto Fiord is approximately 4 km in a northwest-southeast direction. The pass rises only to some 150 m altitude, while the surrounding hills reach heights in excess of 1,000 m. Observations were made in the pass itself, along the shores of both fiords for several kilometres from the pass, in a river valley draining into the northeast shore of the bay in Otto Fiord, and on high ground east of the bay to altitudes of approximately 1,000 m.

The terrain is generally mountainous, but there are extensive areas of level and gently sloping ground in addition to steeper cliffs and scree. The area contains considerable lengths of shoreline and numerous small ponds and streams. A wide variety of habitats is therefore available, but plant cover is restricted by several climatic and edaphic factors.

There are no meteorological data covering extended periods at Van Hauen Pass, but in general features its climate is probably intermediate between that at Tanquary Camp, 160 km to the east, and Eureka, 120 km to the south. Data for these stations can be found in Brassard (1968) and Thompson (1967) respectively. The growing season is short, probably two to three months, but the summers are relatively warm compared with the severity of the winters. Precipitation appears generally to be light, but the lowlands at Van Hauen Pass are less arid than those near Hazen Camp

[1]New York Botanical Garden.
Present address:
Department of Biology, University of Ottawa.
[2]Department of Botany, University of Manitoba.

FIGURE 1. Map of northern Ellesmere Island, indicating the localities mentioned in the text.

or Tanquary Camp. There was no continuous snow cover on low-lying ground during the period of observations but numerous snow banks persisted, particularly on slopes with a northerly aspect, providing moist sheltered habitats with well developed vegetation.

Most of the substrata at Van Hauen Pass are unstable and subject to vigorous solifluction disturbances. Non-sorted frost polygons are widespread, and solifluction is so active that many slopes support only scattered vegetation, the plants growing singly over the wet mud and moving downslope with it. The soils generally consist largely of inorganic material, but an increase in nutrients is found locally as a result of biotic influences and, as elsewhere in the Arctic, this increase results in small stands of unusually luxuriant vegetation.

The Vegetation

The vegetation at Van Hauen Pass is typically high arctic, comprising a series of communities dominated by herbs and less frequently by dwarf shrubs, often with mosses and both fruticose and foliose lichens as important constituents. Mosses occasionally become dominant in wet habitats, while crustose lichens are locally abundant on rocks and scree. There is a considerable variety of closed vegetation, as well as extensive, more sparsely vegetated clay, scree and gravel slopes.

Dry Heath

Heathland dominated by *Dryas integrifolia* covers wide areas of well-drained level ground and gentle slopes in the lowlands. *Dryas* normally forms small compact cushions, but locally, especially near the base of steep slopes, it occurs in large regular hummocks. *Cassiope tetragona* is frequent in the hummocky areas, and *Salix arctica* is widespread and locally dominant. Other common associated species include *Carex misandra, Kobresia myosuroides, Pedicularis arctica, Saxifraga oppositifolia* and the moss *Orthotrichum speciosum*. Less frequently one finds *Carex membranacea, Chrysanthemum integrifolium* and, in wetter stands, *Pedicularis capitata* and *Polygonum viviparum*. Dry heath frequently lacks a well-developed bryophyte understory, the total cover value ranging from 50 to almost 100%, while the height of the vegetation rarely exceeds 15 cm except in the hummocky areas.

Wet Heath

Under moister conditions, lowland plains and slopes, particularly north of the pass, support wet heath that is in many respects intermediate between dry heath and sedge meadows, the three vegetation types commonly intergrading. *Dryas integrifolia, Carex stans* and *Eriophorum scheuchzeri* are normally the dominant species in wet heath, but *Cassiope tetragona* may also be abundant, particularly at the foot of north and west-facing slopes. The ground surface is usually uneven, with *Dryas, Cassiope* and other dry heath species occupying the raised areas, while sedges and rushes are rooted among species of *Drepanocladus* and other mosses in the wetter depressions.

Wet heath is rich in associated species; the more widespread vascular plants include *Arctagrostis latifolia, Carex misandra, Draba lactea, Eutrema edwardsii, Eriophorum triste, Equisetum variegatum, Juncus biglumis, Luzula nivalis, Pedicularis arctica, P. capitata, Polygonum viviparum, Salix arctica* and *Silene acaulis*. These species also occur in other types of vegetation, particularly dry heath, but three additional plant species appear to be restricted to the present vegetation type. Of these, *Epilobium arcticum* occurs sparingly in several localities, while several large populations of *Geum rossii* and a few plants of *Lycopodium selago* were seen in wet heath north and east of the bay in Otto Fiord.

Sedge Meadow

Narrow belts of luxuriant, well-developed sedge meadow are widespread around ponds and along the larger streams. *Carex stans* is abundant in some places, and probably dominates this type of vegetation throughout the area, producing a uniform but open cover with occasional plants up to 30 cm tall. *Eriophorum scheuchzeri* is a frequent associate, and many other vascular plants are common, including *Arctagrostis latifolia, Equisetum variegatum,*

Eutrema edwardsii, Juncus biglumis, Melandrium apetalum, Polygonum viviparum, Saxifraga hirculus and the ubiquitous *Salix arctica*.

The vascular plants are normally rooted in a closed bryophyte understory dominated by *Calliergon giganteum, Cirriphyllum cirrosum, Orthothecium chryseum* and species of *Drepanocladus*. These mosses, with *Cinclidium latifolium, Meesia trifaria* and *Scorpidium turgescens*, are also widespread in almost pure bryophyte communities, occurring partially submerged on the wettest ground around pond margins, where *Ranunculus hyperboreus* is the only common flowering plant.

Upland Seepage Areas

Around Van Hauen Pass, sedge meadow appears to be a characteristically lowland vegetation type. On the higher ground, above 200 to 300 m alt., it is largely replaced on stream banks and in seepage areas by communities dominated by a variety of grass-like plants, including *Alopecurus alpinus, Deschampsia brevifolia, Festuca hyperborea, Juncus biglumis* and *Luzula nivalis*. The ground cover in such meadows is surprisingly high, often approaching 100%. The upland seepage areas also support many other small herbaceous plants such as *Draba lactea, Polygonum viviparum, Ranunculus sulphureus, Saxifraga caespitosa, S. cernua, S. flagellaris* and, less frequently, *Cardamine bellidifolia* and *Saxifraga foliolosa*.

Areas of Snow Accumulation

The numerous late-lying snow banks at Van Hauen Pass commonly give rise to distinct vegetation types. Among these are deep, luxuriant moss turfs formed by *Aulacomnium acuminatum, A. turgidum, Orthothecium chryseum, Philonotis fontana, Tomenthypnum nitens* and species of *Cinclidium*, which commonly surround small snow banks in sheltered hollows. Scattered vascular plants are often conspicuous among the mosses, particularly *Oxyria digyna, Ranunculus sulphureus, Saxifraga cernua* and *S. nivalis*. The bryophyte-dominated vegetation is characteristic of areas adjacent to snow-banks and frequently gives way to a zone dominated by *Cassiope tetragona*, which gradually merges into *Dryas integrifolia* heath, or other vegetation of relatively exposed ground.

Cassiope tetragona is locally abundant also on rock talus slopes north of the pass. There was little snow cover on these slopes in late June, but they probably had extensive snow cover in winter, as ice persisted among the boulders well into July. *Cassiope* here forms large, irregular hummocks compacted by mosses, while a variety of lichens and vascular plants grow among the mosses between the hummocks. *Carex misandra, Dryas integrifolia* and species of *Saxifraga* are common associates, while *Cardamine bellidifolia* and *Vaccinium uliginosum* occur less frequently.

At the foot of the slopes the aforementioned community merges into wet heath, while higher up the plant cover often thins out to leave only a sparse growth of *Cassiope* and *Dryas*. In some places, however, the vascular plants are replaced by abundant mosses, especially *Rhacomitrium lanuginosum* and species of *Polytrichum*, while elsewhere open vegetation develops mainly on the upper slope and includes more xeric vascular plants such as *Arenaria rubella, Cerastium alpinum, Cystopteris fragilis, Potentilla rubricaulis, Saxifraga caespitosa, S. tricuspidata* and *Woodsia glabella*.

Clay Slopes and Plains

Although closed plant communities are extensively developed in the Van Hauen Pass area, aridity and solifluction restrict plant development over wide areas on the plains and slopes of clay and mud. Many gentle clay slopes are regularly dissected into polygons from 1 to 3 m in diameter separated by troughs 30 cm wide and deep. The troughs are well vegetated, with varying proportions of *Dryas integrifolia, Salix arctica* and *Saxifraga oppositifolia* giving 50 to 100% cover. *Pedicularis arctica* is also widespread, though seldom abundant, while there is a well-developed bryophyte understory in which *Hypnum revolutum* and *Tortula ruralis* predominate. In contrast, the dry, cracked mud and clay on the surface of the polygons is generally bare.

Additional, extensive areas of clay are patterned with smaller, irregular hummocks to 50

cm wide by 30 cm high, and support only scattered individuals of *Lesquerella arctica, Oxyria digyna, Poa abbreviata, P. glauca,* and *Potentilla pulchella* with, less frequently, *Braya thorild-wulffii* and *Taraxacum arctogenum.*

Wet clay occurs locally in depressions near streams, and here *Alopecurus alpinus* is almost ubiquitous, while *Carex maritima* and *Equisetum arvense* are locally abundant.

Gravel and Scree

Open vegetation is also widely developed on gravel and scree slopes. *Saxifraga oppositifolia* and *S. tricuspidata* may be locally frequent on these substrata, and *Epilobium latifolium* is often particularly abundant along river banks and in the beds of seasonal streams. Most other gravel and scree slopes have plant cover below 20% but support a large number of species, the most widespread including *Arenaria rubella, Carex nardina, Cerastium alpinum, Draba bellii, D. cinerea, D. groenlandica, D. subcapitata, Festuca baffinensis, Kobresia myosuroides, Lesquerella arctica, Papaver radicatum, Poa abbreviata, P. glauca, Salix arctica, Stellaria edwardsii, S. monantha* and *Taraxacum arctogenum.* Less common are *Androsace septentrionalis, Erysimum pallasii* and *Taraxacum phymatocarpum.*

Another group of species is particularly characteristic of sheltered, well-insolated, south-facing scree slopes. *Arnica alpina* and *Erigeron compositus* are locally frequent in these situations, while *Agropyron violaceum, Erigeron eriocephalus* and *Ranunculus pedatifidus* were seen in small numbers.

Fiord Shorelines

In many places along Hare Fiord and Otto Fiord wet and dry heaths extend almost to the shore, and elsewhere the shorelines are generally clay or gravel with open vegetation similar to that in comparable habitats inland. However, mud and gravel on the shore of Otto Fiord to the east of Van Hauen Pass support four taxa not seen elsewhere in the area, i.e. *Braya purpurascens, Cerastium regelii, Cochlearia officinalis* and *Potentilla pulchella* var. *gracilicaulis,* while *Braya thorild-wulffii, Draba bellii* and *Potentilla pulchella* var. *pulchella* are more frequent there than inland.

Enriched Areas

Any local increase in nitrogen and phosphates, as around bird perches, muskox carcasses and lemming burrows, results in exceptionally luxuriant vegetation (Porsild 1955). At Van Hauen such areas support a few species not encountered elsewhere, notably *Melandrium affine,* while plants of more widespread species are there often strikingly larger than plants of the same species growing nearby in other habitats. The latter group frequently included *Alopecurus alpinus, Cerastium alpinum, Luzula confusa, Papaver radicatum, Polygonum viviparum* and species of *Draba* and *Stellaria.*

Numerous mosses are also found in the enriched areas. *Abietinella abietina* and *Tortula ruralis* were regularly recorded on large bird perches, while dung and the entrances to lemming burrows provide habitats for strongly nitrophilous species such as *Funaria polaris, Haplodon wormskjoldii, Splachnum vasculosum,* and *Tetraplodon mnioides.*

A different type of soil enrichment is seen locally in sheltered areas, where fragmented willow leaves and other wind-blown organic debris become enclosed in snowdrifts, and, later are deposited on the surface of the vegetation as the snow melts. The incorporation of such plant remains into the soil may well contribute to the richness of the vegetation in these local habitats.

Discussion

The total of 80 species and one variety of vascular plants recorded at Van Hauen Pass (Appendix 1) is a substantially lower figure than reported from other localities in northern Ellesmere Island: 119 from Tanquary Camp (Brassard and Beschel 1968), 110 from Hazen Camp (Savile 1964; Brassard and Longton 1969) and 107 from Eureka (P. Bruggemann unpublished data; R. Beschel unpublished data). However, these areas have been far more thoroughly explored than Van Hauen Pass, where the present collections were made early in the summer when many species, especially

grasses and sedges, were only beginning to flower. Moreover, a fire four days prior to the termination of the observations accidentally destroyed most of the specimens collected up to that point, and not all were replaced. With two exceptions the list is based on specimens which were saved or which were collected after the fire. Field lists and notes are the basis for our description of the vegetation. The flora at Van Hauen Pass is probably comparable in richness with those in other areas in the interior of northern Ellesmere Island, which appear to support a greater diversity of flowering plants than outer coastal stations at similar latitudes (Savile 1964).

The composition of the floras at Van Hauen Pass, Eureka, Hazen Camp and Tanquary Camp is also strikingly similar. All the species reported at Van Hauen Pass have been collected in at least one of the other localities, and no less than 69 of the 80 species are known from all four stations. For example, it is interesting to note that *Festuca hyperborea,* only recently described from Peary Land (Holmen 1952), has been collected at all the localities except Eureka, and thus appears to be widely distributed on northern Ellesmere Island.

Geum rossii was one of the most notable finds at Van Hauen Pass. Eureka is the only other Ellesmere Island locality so far reported for this western Arctic species, and Van Hauen Pass becomes its most northerly known station. *Potentilla pulchella* var. *gracilicaulis,* another western Arctic taxon, has not previously been reported from any of the Queen Elizabeth Islands, and the present collection from Van Hauen Pass, where it was growing with var. *pulchella,* extends its known range both to the north and east. *Epilobium arcticum,* common at Van Hauen Pass, in Ellesmere Island is known otherwise only from Hazen Camp.

Several of the species rare at Van Hauen Pass may also be generally uncommon on Ellesmere Island as a whole, as they have so far been reported from only a few localities: these include *Chrysanthemum integrifolium, Erigeron eriocephalus, Lycopodium selago, Vaccinium uliginosum* and *Woodsia glabella.* Two other species, *Arnica alpina* and *Silene acaulis,* are considerably more frequent at Van Hauen Pass than at either Hazen Camp or Tanquary Camp, but conversely, there is a striking scarcity of maritime species along the shores of both Hare Fiord and Otto Fiord. For example, the widespread halophytes *Armeria maritima, Puccinellia phryganodes* and *Stellaria humifusa* were not recorded.

The principal plant communities at Van Hauen Pass are broadly similar to those at Hazen Camp and around the head of Tanquary Fiord, but there are marked differences in their frequency and distribution. Extensive wet and dry heaths are less frequent on low ground near Tanquary Camp than at Van Hauen, while at Hazen, dry heath is widespread at altitudes as low as 200 m but wet heath is extensive only above 400 m. At both eastern stations, however, the heaths are marked by more frequent development of large regular hummocks of *Dryas integrifolia* and *Cassiope tetragona* than at Van Hauen Pass. Sedge meadow is particularly characteristic of the lowlands at Van Hauen Pass, but near Tanquary Camp this community occurs from sea level but is most widespread at altitudes of 300 m to 600 m, due to the greater frequency of wet habitats on the higher ground. On the clay slopes and plains at Van Hauen Pass the vegetation, although often sparse, is better developed than in similar habitats around the head of Tanquary Fiord, where extensive areas bear a superficial crust of salts and are virtually devoid of plants.

Aridity was regarded as the most important single factor limiting the development of vegetation at Hazen Camp by Savile (1964), who noted that both mean summer air temperatures and the duration of sunshine were strikingly high with respect to latitude, and he regarded the area as an outstanding example of a post-hypsithermal refugium. Similar considerations may apply to Tanquary Camp, but aridity appears to be somewhat less severe at Van Hauen Pass and this is reflected in the noticeably more luxuriant development of vegetation in much of the lowlands there than at the other two stations. Nevertheless, the ground water supply remains a critical factor determining the distribution of the different vegetation types,

while aridity, combined with solifluction disturbances, may be largely responsible for the extensive areas of sparsely vegetated clay, gravel and scree. Discussing the neighbouring Axel Heiberg Island, Beschel (1963) notes that "The vegetation characteristic for the low areas on the cold and oceanic west coast can only be found at progressively higher altitudes farther east". The present observations suggest that a similar pattern may exist on northern Ellesmere Island.

Acknowledgments

Brassard's participation in these studies was supported by National Science Foundation (U.S.A.) Grant GB-1313 to W. C. Steere. Longton was a member of the Royal Air Force Ellesmere Island Expedition on leave of absence from the British Antarctic Survey. We thank Dr. G. Hattersley-Smith and the Defence Research Board of Canada for logistic support, and Dr. A. E. Porsild for confirming or revising many of our determinations in critical groups.

Literature Cited

Beschel, R. E. 1963. Geobotanical studies on Axel Heiberg Island in 1962. In: Müller, F. et al. Axel Heiberg Island Preliminary Report 1961-1962: 199-215. McGill University.

Brassard, G. R. 1967a. Botany. In: Hattersley-Smith, G. ed. Operation Tanquary Preliminary Report, 1964. Defence Research Board, Canada: D Phys R (G) Hazen 25: 37-42.

Brassard, G. R. 1967b. New or additional moss records from Ellesmere Island. Bryologist 70: 251-256.

Brassard, G. R. 1968. The plant habitats of Tanquary Camp, Ellesmere Island, N.W.T. Defence Research Board, Canada: D. Phys R (G) Hazen 32: 11 pp.

Brassard, G. R. and **R. E. Beschel.** 1968. The vascular flora of Tanquary Fiord, northern Ellesmere Island. Canadian Field-Naturalist 82: 103-113.

Brassard, G. R. and **R. E. Longton.** 1969. Floristic studies. In: Botanical studies in northern Ellesmere Island in 1967: a preliminary report. Defence Research Board, Canada: D Phys R (G) Hazen 38: 1-5.

Bruggemann, P. F., and **J. A. Calder.** 1953. Botanical observations in northeast Ellesmere Island, 1951. Canadian Field-Naturalist 67: 157-174.

Holmen, K. 1952. Cytological studies in the flora of Peary Land, North Greenland. Meddelelser om Grønland 128: 1-40.

Longton, R. E. 1969. Studies on growth and reproduction in mosses. In: Botanical studies in northern Ellesmere Island in 1967: a preliminary report. Defence Research Board, Canada: D Phys R (G) Hazen 38: 6-9.

Porsild, A. E. 1955. The vascular plants of the Western Canadian Arctic Archipelago. National Museum of Canada Bulletin, No. 135: 226 pp.

Porsild, A. E. 1964. Illustrated flora of the Canadian Arctic Archipelago. National Museum of Canada Bulletin. No. 146, 2nd. ed.: 218 pp.

Powell, J. M. 1961. The vegetation and microclimate of the Lake Hazen area, northern Ellesmere Island, N.W.T. Defence Research Board, Canada: D Phys R (G) Hazen 14: 112 pp.

Powell, J. M. 1967. Some lichens and bryophytes from the Lake Hazen area, Ellesmere Island, N.W.T., Canada. Bryologist 70: 246-250.

Savile, D. B. O. 1964. General ecology and vascular plants of the Hazen Camp area. Arctic 17: 237-256.

Schuster, R. M., Steere, W. C., and **J. W. Thomson.** 1959. The terrestrial cryptogams of northern Ellesmere Island. National Museum of Canada Bulletin. No. 164: 132 pp.

Soper, J. H. 1959. Botany. In: Hattersley-Smith, G. ed. Operation Hazen Narrative and Preliminary Reports 1957-58. Defence Research Board, Canada: D Phys R (G) Hazen 4: 80-82.

Thompson, H. A. 1967. The climate of the Canadian Arctic. In Canada Year Book 1967: 55-74. Dominion Bureau of Statistics, Ottawa.

Appendix 1. Vascular plants recorded at Van Hauen Pass

Eighty species and one variety of vascular plants were recorded at Van Hauen Pass, as listed below. Specimens were obtained of all except two taxa (*Saxifraga foliolosa* and *Stellaria edwardsii*). The collection numbers indicated are those of Brassard (B) and Longton (L), whose collections are deposited respectively in the National Herbarium, Ottawa (CAN) and the British Antarctic Survey Herbarium at the Department of Botany, University of Birmingham.

Equisetum arvense L. (L 1607)
Equisetum variegatum Schleich. (B 3012)
Lycopodium selago L. (L 1581)
Woodsia glabella R. Br. (B 3015, L 1541, L 1563)
Cystopteris fragilis (L.) Bernh. ssp. *dickieana* (Sim.) Hyl. (B 3016, L 1749)
Alopecurus alpinus J. E. Sm. (B 3042, L 1773)

Arctagrostis latifolia (R. Br.) Griseb. (B 2900, L 1761)
Deschampsia brevifolia R. Br. (B 2902)
Trisetum spicatum (L.) Richt. (B 2899)
Poa abbreviata R. Br. (B 2903, L 1564)
Poa glauca M. Vahl. (B 2904)
Festuca baffinensis Polun. (B 2898, L 1767)
Festuca hyperborea Holmen (B 2888)
Agropyron violaceum (Hornem.) Lange (B 2896)
Eriophorum scheuchzeri Hoppe (B 3045, L 1443)
Eriophorum triste (Th. Fr.) Hadač & Löve (B 3046, L 1762)
Kobresia myosuroides (Vill.) Fiori & Paol. (B 3035, L 1586)
Carex maritima Gunn. (L 1774)
Carex membranacea Hook. (B 3007)
Carex misandra R. Br. (B 3032, L 1759)
Carex nardina Fr. var. *atriceps* Kük. (B 3034, L 1585)
Carex rupestris All. (L 1608)
Carex stans Drej. (L 1566)
Juncus biglumis L. (B 3040, L 1567)
Luzula confusa Lindeb. (B 3005, L 1561)
Luzula nivalis (Laest.) Beurl. (B 3044, L 1754)
Salix arctica Pall. (L 1760)
Oxyria digyna (L.) Hill (B 3030)
Polygonum viviparum L. (L 1606)
Stellaria edwardsii R. Br.
Stellaria monantha Hult. (B 3004, L 1770)
Cerastium alpinum L. *s.l.* (B 3027, L 1771)
Cerastium regelii Ostf. (L 1778)
Arenaria rubella (Wahlenb.) Sm. (B 3010, L 1751, L 1768)
Silene acaulis L. var. *exscapa* (All.) DC. (B 3039, L 1787)
Melandrium affine (J. Vahl) Hartm. (B 3008)
Melandrium apetalum (L.) Fenzl ssp. *arcticum* (Fr.) Hult. (L 1756)
Ranunculus hyperboreus Rottb. (L 1775)
Ranunculus pedatifidus Sm. var. *leiocarpus* (Trautv.) Fern. (L 1746)
Ranunculus sulphureus Sol. (B 3013, L 1744)
Papaver radicatum Rottb. *s.l.* (L 1743)
Cochlearia officinalis L. ssp. *groenlandica* (L.) Porsild (L 1748)
Eutrema edwardsii R. Br. (B 3011)
Cardamine bellidifolia L. (B 3019)
Lesquerella arctica (Wormskj.) Wats. (B3024, L 1769)
Draba bellii Holm (B 3036, L 1777)
Draba cinerea Adams (B 3025)
Draba groenlandica El. Ekman (L 1509, L 1772, L 1776)
Draba lactea Adams (B 3009, L 1753)
Draba subcapitata Simm. (B 3017, L 1510)
Erysimum pallasii (Pursh) Fern. (B 3029)
Braya purpurascens (R. Br.) Bunge (L 1780)
Braya thorild-wulffii Ostenf. (L 1781)
Saxifraga caespitosa L. *s.l.* (L 1783)
Saxifraga cernua L. (B 3006)
Saxifraga flagellaris Willd. ssp. *platysepala* (Trautv.) Porsild (L 1745)
Saxifraga foliolosa R. Br.
Saxifraga hirculus L. var. *propinqua* (R. Br.) Simm. (L 1755)
Saxifraga nivalis L. (B 3003)
Saxifraga oppositifolia L. (B 3037)
Saxifraga tenuis H. Sm. (B 3047)
Saxifraga tricuspidata Rottb. (B 3038, L 1765)
Potentilla nivea L. ssp. *chamissonis* (Hult.) Hiit. (B 3018)
Potentilla pulchella R. Br. var. *pulchella* (L 1782a)
Potentilla pulchella var. *gracilicaulis* Porsild (L 1782b)
Potentilla rubricaulis Lehm. (B 3002, B 3028, L 1752)
Dryas integrifolia M. Vahl (B 3022, L 1758)
Geum rossii (R. Br.) Sér. (B 3000, L 1786)
Epilobium arcticum Samuelss. (B 3014)
Epilobium latifolium L. (L 1747)
Cassiope tetragona (L.) D. Don. (B 3033, L 1757)
Vaccinium uliginosum L. var. *alpinum* Big. (L 1736)
Androsace septentrionalis L. (B 3031, L 1750)
Pedicularis arctica R. Br. (B 3123, L 1764)
Pedicularis capitata Adams (B 3020)
Erigeron compositus Pursh (B 3026, L 1528)
Erigeron eriocephalus J. Vahl (B 3001)
Chrysanthemum integrifolium Richards. (B 3041, L 1763)
Arnica alpina (L.) Olin ssp. *angustifolia* (Vahl) Maguire (L 1748)
Taraxacum arctogenum Dahlst. (L 1766)
Taraxacum phymatocarpum J. Vahl (B 3043)

Received December 31, 1969
Accepted May 22, 1970

Observations on the Fish Fauna of the Leaf River, Ungava

B. M. Jessop, R. L. G. Lee and G. Power
Department of Biology, University of Waterloo, Waterloo, Ontario

Abstract. Species of fish in decreasing order of abundance were: *Salvelinus fontinalis, Prosopium cylindraceum, Salvelinus alpinus, Salmo salar, Catostomus catostomus, Cottus cognatus, Salvelinus namaycush, Coregonus clupeaformis, Lota lota, Gasterosteus aculeatus, Pungitius pugitius*. Brief notes are provided on each species.

Introduction

Only in recent years has the Ungava Bay watershed of northern Quebec attracted the attention of fisheries biologists. The contributions of early scientists and explorers are summarised by Dunbar and Hildebrand (1952). This note is based on fish caught in a twelve mile section of the lower Leaf River centered at 58° 39′ N, 70° 25′ W. Fish were collected using a variety of gill nets from ¾″ mesh monofilament to 6″ mesh multifilament, fished in water from 3-15′ deep. A bag seine was also employed. Four tributary streams were sampled using rotenone. This report provides information on all species of fish found during the study. Detailed reports on some species will be published separately. Data obtained in the field included fork length, weight, sex and state of maturity. Materials for age determination were either scales or otoliths or for some species, both. Samples of all species recorded have been deposited with the National Museum of Natural Sciences, National Museums of Canada, Ottawa and are represented in the collections catalogued under NMC 69-145 to NMC 69-187 inclusive.

The Leaf River

The Leaf River originates at Lake Minto on the western side of the Ungava peninsula at 600′ above sea-level and runs over 200 miles north-eastward to drain into Ungava Bay. The river is swift and contains several stretches of rapids. The volume of water discharged may range from over 180,000 cubic feet per second during the spring run-off in June to under 600 cubic feet per second in March and April (communication from Ministère des Richesses Naturelles, Québec).

The climate is arctic or subarctic in nature with much of the area underlain with permafrost. Trees, such as tamarak and spruce, are only found in the river valley and other sheltered areas. Hustich (1953) considers that the Leaf River lies on the northern limit of trees.

Species Account

Eleven species of fish were caught; all have been previously recorded from Ungava by Dunbar and Hildebrand (1952). One species, the burbot, has not previously been recorded from the Leaf River drainage. Three other species, the round whitefish, the threespine stickleback and the slimy sculpin have been recorded as present in the Finger River which drains into Leaf Bay (Bateman, 1953).

Atlantic salmon, *Salmo salar* Linnaeus.

McLean (1849) first reported the presence of the Atlantic salmon in Ungava. Power (1969) has examined specimens of the species caught in Leaf Bay. The 383 salmon caught during 1968 are the first definite record of the species ascending the river in appreciable numbers for spawning. Before this, they had been reported as strays by Dunbar and Hildebrand (1952).

The 383 fish caught consisted of 8 parr, 311 smolts and 64 adults. The smolts consisted of 101 males of which 65 were ripe, and 218 females of which 9 were ripe. The mean age of the migratory non-ripe smolts was 5.12 winters and the mean length was 26.1 cm. Only 17 of the 64 adult salmon were male, 9 had previously spawned and 17 had spawned or were about to spawn as grilse. The first adult salmon was caught on July 7 but they did not become common until mid-August.

Arctic char, *Salvelinus alpinus* (Linnaeus).

McLean (1849) correctly recorded the occurrence of Arctic char in the Ungava Bay watershed although char has often been confused with the Atlantic salmon. A total of 561 Arctic char were examined. Early in July, a few specimens in poor condition

were handled that were presumably moving downstream into the sea. The majority of the fish were caught as they moved upstream from the sea. Eight very small, stunted specimens were taken which showed no evidence of having been to sea. It is possible that there is a small non-migratory char population present in the river. The anadromous char appear to be relatively fast growing but short lived. Lengths in excess of 60 cm are attained by the tenth year, few fish survive beyond the fifteenth year. The char, like the salmon, spawn far upriver and no fry were caught. The Leaf River is the only known river in North America ascended by the Arctic char and Atlantic salmon in appreciable numbers.

BROOK TROUT, *Salvelinus fontinalis* (Mitchell).

This species was first recorded by Kendall (1909) in Ungava and is known to be abundant in the area (Power and Oliver, 1961). In the Leaf River it is the most abundant species. Over 800 were caught in gill nets and over 600 fry and yearlings were taken in rotenone samples. Few of the fish caught showed evidence of having migrated to the sea.

Fry attain lengths of about 5 cm at the end of the first summer, annual increments of growth in subsequent years are somewhat less than 5 cm. Trout age 6+ have a mean length 28.8 cm, range 25.5-36.5 cm. Maximum age recorded from scale reading was 9+ years; fish in this age group had a mean length of 40.8 cm.

LAKE TROUT, *Salvelinus namaycush* (Walbaum).

The widespread presence of the lake trout in Ungava has been noted by Harper (1961). Only 43 specimens were taken in the Leaf River making it one of the rarer fishes present. The largest specimen caught weighed less than 2 lb. This is in marked contrast to the neighbouring Kohsoak River where specimens of 15 lb weight are not uncommon.

ROUND WHITEFISH, *Prosopium cylindraceum* (Pallas).

This species was previously thought to be rare in the Ungava region. Power and Oliver (1961) reported that it is relatively abundant in the Koksoak, George and Whale Rivers. On the eastern side of the Ungava peninsula, the northernmost record was formerly Bateman's (1953) at Iron Lake south of Leaf Bay. This survey extends the record to the Leaf River. On the western side of the peninsula, specimens have been taken farther north from the Povungnituk River (McAllister, 1964).

The Leaf River round whitefish is a small slow growing fish. By age 8+ the mean length is approximately 30 cm; beyond this age the fish is not abundant but specimens up to age 14+, mean length of 37 cm, were taken.

LAKE WHITEFISH, *Coregonus clupeaformis* (Mitchill).

Only 30 specimens were taken during the summer. The largest was a female 37.7 cm in length, age 6+. Most specimens ranged from 19-25 cm and ages 2+-3+. Flaherty (1918) recorded this species from the Leaf River, but there are no definite records of the lake whitefish occurring further north in the Ungava Bay area (Dunbar and Hildebrand, 1952).

LONGNOSE SUCKER, *Catostomus catostomus* (Forster).

This species has been reported as widespread and common in Ungava by various authors (Harper, 1961). It was common in the Leaf River and over 200 specimens were caught.

BURBOT, *Lota lota* (Linnaeus).

Three specimens were caught on August 22; the largest was a 52 cm, 689 g male. Several smaller specimens were taken in small streams using rotenone. This species has occasionally been recorded from Ungava (Dunbar and Hildebrand, 1952; Power and Oliver, 1961). These specimens are the first record of the species from the Leaf River.

THREESPINE STICKLEBACK, *Gasterosteus aculeatus* Linnaeus.

This species has a circumpolar distribution and is known to be common throughout Ungava (Harper, 1961). This is the first record of the species in the Leaf River although Bateman (1953) found it common in the Finger River drainage and Legendre and Rousseau (1949) found it in Payne Lake. Few specimens were obtained and these were all taken from the main river by seining.

NINESPINE STICKLEBACK, *Pungitius pungitius* (Linnaeus).

This species is regarded as widespread in Ungava (Dunbar and Hildebrand, 1961) and Bateman (1953) found it abundant in the Finger River. The few specimens that were caught in the Leaf River were all taken in rotenone samples. All specimens had ten spines.

SLIMY SCULPIN, *Cottus cognatus* Richardson.

This collection extends the range of this species to the Leaf River. This species is widespread in Ungava (Harper, 1961). Bateman (1953) found it common in the Finger River. In the small tributary streams it was very common and the co-dominant species with the brook trout.

Acknowledgments

Funds for this study were provided by the National Research Council, the National Museum of Natural Sciences and the Atlantic Salmon Association through grants to Dr. G. Power. Dr. D. E. McAllister, Curator of Fishes at the National Museum of National Sciences,

Ottawa, confirmed the identifications of the specimens and assigned the Museum collection numbers.

Literature Cited

Bateman, B. 1953. Observations on the natural history of the Leaf Bay, Fort Chimo region, Ungava, Quebec. Intermediate Naturalist 8: 1-7.

Dunbar, M. J. and **H. H. Hildebrand.** 1952. Contribution to the study of the fishes of Ungava Bay. Journal of the Fisheries Research Board of Canada 9(2): 83-128.

Flaherty, R. J. 1918. Two traverses across Ungava Peninsula, Labrador. Geographical Review 6(2): 116-132.

Harper, F. 1961. Field and historical notes on fresh-water fishes of the Ungava peninsula and on certain marine fishes of the north shore of the Gulf of St. Lawrence. Journal of the Elisha Mitchell Science Society 77(2): 312-342.

Hustich, I. 1953. The boreal limits of conifers. Arctic 6(2): 149-162.

Kendall, W. C. 1909. The fishes of Labrador. Proceedings of the Portland Society of Natural History 2: 207-244.

Legendre, V. and **J. Rousseau.** 1949. La distribution de quelques-uns de nos poissons dans le Québec Arctique. Annales de l'ACFAS 15: 133-135.

McAllister, D. E. 1964. Fish collections from eastern Hudson Bay. Canadian Field-Naturalist 78(3): 167-178.

McLean, J. 1849. Twenty-five years service in the Hudson Bay Territory. 2 vols. R. Bentley: London. Reprinted by Champlain Society, Toronto. 1 vol. (1932). 402 p.

Power, G. 1969. The Salmon of Ungava Bay. Arctic Institute of North America Technical Report 22. 72 p.

Power, G. and **D. R. Oliver.** 1961. Notes on the distribution and relative abundance of the fresh-water fish in Ungava. Canadian Field-Naturalist. 75(4): 221-224.

Received November 18, 1969
Accepted December 30, 1969

Seabird Transects between Valleyfield and Funk Island, Newfoundland, Summer, 1969

DAVID N. NETTLESHIP[1] AND C. ERIC TULL
Department of Zoology, McGill University, Montreal, Quebec.
PIROP, Departement de Biologie, Université de Moncton, Moncton, N.B.

Abstract. This paper describes the total number of seabirds observed during three continuous watches (17 June, 18 July, 29 August 1969) along the same transect line between Valleyfield and Funk Island, Newfoundland, and sightings made over the coastal zone of the transect (23 April 1969) and off Funk Island (9 May, 18 July 1969). The species composition and the seasonal changes in abundance and distribution have been described. Species recorded were: *Puffinus griseus, P. gravis, Fulmarus glacialis, Oceanodroma leucorhoa, Oceanites oceanicus, Morus bassanus, Stercorarius pomarinus* and/or *S. parasiticus, Catharacta skua, Larus hyperboreus* and/or *L. leucopterus, L. marinus, L. argentatus, Pagophila eburnea, Rissa tridactyla, Sterna hirundo, S. paradisaea, Alca torda, Uria aalge, U. lomvia, Cepphus grylle,* and *Fratercula arctica.*

Introduction

In connection with studies on the Common Puffin by the senior author, three trips were scheduled from Valleyfield to Funk Island, Newfoundland, during the 1969 summer season. We felt that counts of seabirds sighted along the same transect at different times of the summer (mid-June, mid-July, late August) would permit us to document the changes in species composition, abundance, and distribution. Ideally, observations of seabirds should be analyzed closely with the biotic (food supply) and abiotic (physical and chemical properties) characteristics of the marine environment. However, less comprehensive transects, which relate occurrence and distribution of seabirds with time of the year are still important contributions to the preliminary understanding of their ecology at sea. It is the purpose of this paper to present this descriptive information.

The transect extended from outside the harbour at Valleyfield (49°06′N., 53°37′W.) roughly NNE to Funk Island (49°46′N., 53° 11′W.), situated some 35 miles out from the Newfoundland coast (Figure 1). The total length of the transect measured approximately 48 miles. For convenience, we have divided it into three zones: 1. coastal: (c.16 miles long) from Valleyfield along the coast towards Cape Freels, the last point of land; 2. inshore: (c.16 miles long) five and one-half miles off Cape Freels out to 49°32′N., 53°18′W.; and 3. off-

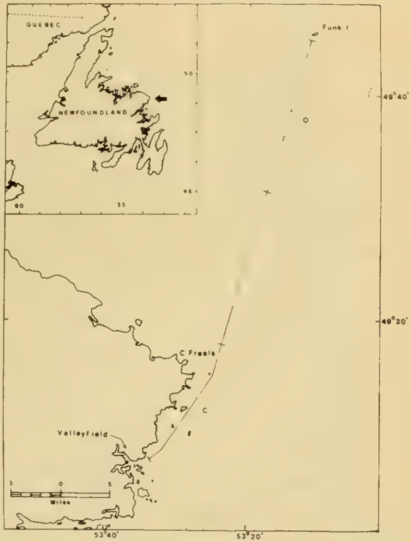


FIGURE 1. Position and zonation (C = coastal zone, I = inshore zone, O = offshore zone) of transect line between Valleyfield and Funk Island, Newfoundland. The broken line respresents the 100 fathom (182.9 m) line. The inset map shows the location of the observation area off the east coast of Newfoundland.

[1]Present address: Edward Grey Institute of Field Ornithology, Oxford University, Botanic Garden, High Street, Oxford, England.

TABLE 1. — Counts of Sooty Shearwaters in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	5	4	1	10
18 July	–	21	2	23
29 Aug.	–	—	1	1

TABLE 2. — Counts of Greater Shearwaters in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	209	118	31	358
18 July	–	412	58	470
29 Aug.	–	1	4	5

shore: (c.16 miles long) from 49°32′N., 53° 18′W. to Funk Island. Each bird seen along the entire transect was recorded. Both authors made the observations on the 17 June (0515 to 1031 hours), while Nettleship did the 18 July (0511 to 0952 hours) and 29 August (0415 to 0845 hours) transects with the assistance of other people (see Acknowledgements). The observation period in the coastal zone in August was shortened because of darkness from departure (0415 hours) to twilight (c.0500 hours).

We have included some observations made by Dr. R. G. B. Brown and Mr. D. I. Gillespie on a low level flight over the coastal zone of the transect on the 23 April 1969 and off Funk Island by PIROP (Programme Intégré de Recherches sur les Oiseaux Pelagiques) observers on the 9 May and 18 July 1969.

Funk Island is a breeding site for Gannets, Great Blackbacked Gulls, Herring Gulls, Kittiwakes, Razorbills, Common Murres, Thick-billed Murres, Common Puffins, and possibly Black Guillemots.

Seabird Observations

1. SOOTY SHEARWATER *Puffinus griseus*

The Sooty Shearwater apparently arrives on the Grand Banks in late March, but does not appear in Newfoundland bays until early May (Tuck, 1967). Observations made in the vicinity of our transect support this view. None were seen over the coastal zone on the 23 April (Dr. R. G. B. Brown, pers. comm.) or off Funk Island on the 9 May 1969 (Dr. P. Germain, pers. comm.).

We saw Sooty Shearwaters in small numbers on all three transects. They were usually seen singly or in pairs, in association with Greater Shearwaters. Table 1 shows the distribution of the birds sighted and the changes during the summer.

In mid-June they were observed chiefly in the coastal and inshore zones. Only one bird was seen in the offshore portion of the transect. In July none were sighted in the coastal zone and only two in the offshore zone; they were most abundant in the inshore zone. Only a single bird was seen on the August transect. These changes in distribution and in total numbers with time of the season parallel those observed for the Greater Shearwater.

2. GREATER SHEARWATER *Puffinus gravis*

Greater Shearwaters arrive in Newfoundland waters in early March, slightly earlier than the Sooty Shearwater (Rees, 1964; Tuck, 1967). It was not observed in the transect area on the 23 April (Dr. R. G. B. Brown, pers. comm.) or 9 May 1969 (Dr. P. Germain, pers. comm.).

We found this shearwater to be the second most abundant seabird during the June and July transects. Greater Shearwaters were most abundant in coastal and inshore waters in June (Table 2). A shift in their distribution was observed in July, with large numbers in the inshore zone and none in the coastal zone. Flocks of 30 to 60 birds were often observed in the inshore zone. In other areas, they were seen in two's and three's. However, the absence of shearwaters in the coastal zone on the second transect may be correlated with the weather rather than the time of the season, as shearwaters are known to come closer to shore during foggy and rough weather (Templeman,

FIGURE 2. Seabirds over the ocean. Mixed group of Greater Shearwaters, Sooty Shearwaters and Fulmars. Photo Courtesy Dr. P. Germain.

FIGURE 3. Greater Shearwater landing on the sea surface. Photo Courtesy Dr. P. Germain.

1945). The June transect was made in poor weather (overcast sky and light fog), whereas weather conditions in July were clear. In late August only five birds were sighted; four of these were recorded in the offshore zone close to Funk Island. These changes in distribution may be a result of migratory behaviour, differential food supply and/or surface water isotherms. Templeman (1945) suggests that the occurrence of shearwaters in inshore water in June and July may be due to changes in the distribution of capelin during spawning.

3. FULMAR *Fulmarus glacialis*

The highest number of Fulmars was recorded on the June transect in the inshore and offshore zones (Table 3). We saw these birds in the same areas in July and August, but in far lower numbers. On the June transect we experienced some difficulty in preventing birds that followed and circled the boat from being recounted. However, our impression is that this source of error was not significant.

It is interesting to note the change in the proportion of the colour phases with the time of the season. In early May 1969 Dr. R. G. B. Brown (pers.comm.) recorded 435 light phase and seven dark phase (1.6% dark) birds in the Funk Island region. On the June transect eight (7.3%) of 109 birds seen were in dark phase plumage, whereas 17 (85%) of the 20 Fulmars observed in July and August were dark birds. The absolute numbers of dark phase birds remained constant on each tran-

TABLE 3. — Counts of Fulmars in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	3	48 (4)*	58 (4)	109 (8)
18 July	–	4 (4)	7 (5)	11 (9)
29 Aug.	–	4 (4)	5 (4)	9 (8)

*(No. dark-phase birds).

sect (Table 3); therefore, the change in the ratio of the plumage types may have been due to the withdrawal of the light phase birds. Salomonsen (1965) discusses the significance of the colour phases and Brown (1968) has recently reviewed the problems of their interpretation in Newfoundland and Greenland waters.

4. Storm Petrels

We saw storm petrels in the inshore and offshore zones on all three transects (Table 4). Two of the petrels observed in the inshore zone in June are thought to have been Wilson's Petrel *Oceanites oceanicus*, while all other sightings were Leach's Petrel *Oceanodroma leucorhoa*. The difficulty in quickly separating these two species prevents accurate determinations, and so we have grouped the small petrel observations together.

FIGURE 4. Fulmar (light phase) sitting on sea surface. Photo courtesy Dr. P. Germain.

TABLE 4. — Counts of storm petrels in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	—	3	5	8
18 July	—	–	16	16
29 Aug.	—	2	1	3

5. Gannet *Morus bassanus*

Twenty-nine adult Gannets were seen near Cape Freels on the 23 April 1969 (Dr. R. G. B. Brown, pers.comm.) and many were recorded toward the Funks in early May (Dr. P. Germain, pers.comm.).

TABLE 5. — Counts of Gannets in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	26	32	43	101
18 July	118	44	40	202
29 Aug.	–	7	6	13

Gannets were common in all three zones of the transect (Table 5). Almost all of the birds were seen in adult plumage and most probably belonged to the Funk Island breeding colony. The increase in the number of sightings on the July transect may have been due to the phase of the Gannet breeding cycle at the time. On the 17 June, incubation was well underway at Funk Island, while in July many Gannet nests contained a chick. The increase in the coastal zone accounts for almost the entire change in total numbers on the July transect. This coastal increase in birds may be correlated with a shift in the distribution of capelin and mackerel. The reason for the low numbers on the 29 August is not known. However, it may have been caused by a change in fish abundance in the transect area.

TABLE 6. — Counts of Great Black-backed Gulls and Herring Gulls in the transect zones.

Transect	Great Black-backed Gull				Herring Gull			
	Coastal	Inshore	Offshore	Total no.	Coastal	Inshore	Offshore	Total no.
17 June	2	—	1	3	54	—	2	56
18 July	17	—	—	17	10	—	–	10
29 August	—	4(2/2)*	14(2/12)	18(4/14)	4(2/2)	10(7/3)	6(3/3)	20(12/8)

*(adults + subadults/fledglings)

6. JAEGERS

We saw these birds only during the June transect. Our five observations were most probably a mixture of Pomarine Jaegers *Stercorarius pomarinus* and Parasitic Jaegers *Stercorarius parasiticus*, but the distance of the birds from the boat made a definite species determination impossible. One light-phase bird was seen in the coastal zone; two light-phase and one dark-phase in the inshore zone; and one light-phase bird in the offshore zone. One Skua *Catharacta skua* was sighted close to Funk Island east of our transect line on the 18 July 1969 by PIROP observers (Dr. P. Germain, pers. comm.).

TABLE 7. — Counts of Kittiwakes in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	5	5	18	28
18 July	11	11	—	22
29 Aug.	—	1(–/1)*	5(–/5)	6(–/6)

* (adults + subadults/fledglings)

7. *Larus* GULLS

Large flocks of Herring Gulls *Larus argentatus* and Great Black-backed Gulls *Larus marinus* with small numbers of Glaucous Gulls *Larus hyperboreus* or Iceland Gulls *Larus leucopterus* were at the edge of the ice off the Little Fogos (49°49′N., 54°06′W.) on the 23 April 1969. Towards Cape Freels only one Glaucous or Iceland Gull was seen (Dr. R. G. B. Brown, pers.comm.). In early May, Herring Gulls, Great Black-backed Gulls, Glaucous and/or Iceland Gulls and non-*Larus* Ivory Gulls *Pagophila eburnea* were recorded off Funk Island (Dr. P. Germain, pers.comm.).

The majority of the *Larus* gulls observed in June and July were distributed close to the coast (Table 6). Both Great Black-backed Gulls and Herring Gulls displayed a similar distribution on all three transects: most birds (mainly adults) were in the coastal zone, none in the inshore zone, and low numbers in the offshore zone towards Funk Island, on the June and July transects; on the 29 August, adults, subadults, and fledglings (birds of the year) were distributed over all three zones and most common in inshore and offshore waters.

Our August transect does not show any tendency for the concentration of first-year birds to coastal areas, while the distribution of adults and subadults extends out to sea (inshore and offshore zones) as described by Brown (1967, 1968) for Canadian gulls in the spring. It is reasonable to conclude that this spatial separation of the age classes, attributed to the differential feeding efficiency of the birds, does not occur until the pressure of winter food shortages forces the dark first year birds to move towards the coast, where they apparently encounter more favorable feeding conditions. However, the absence of dark birds in the coastal zone may be a direct result of the shortened observation period in this zone on the August transect.

TABLE 8. — Counts of terns in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	28	–	2	30
18 July	49	–	2	51
29 Aug.	—	1	10	11

TABLE 9. — Counts of murres in the transect zones

Transect	Coastal	Inshore	Offshore	Total no.
17 June	544	514	1,894	2,952
18 July	64	153	326	543
29 Aug.	—	1	2	3

8. KITTIWAKE *Rissa tridactyla*

Most of the birds we observed in June and July were adults (Table 7). The total number along these two transects was similar, but a change from offshore into coastal and inshore areas occurred. No adults or subadults were seen during the August transect; all six sightings were fledglings. Movement away from the breeding colonies at Funk, Baccalieu, and the Witless Bay islands begins in late July and is close to completion by the end of August.

9. TERNS

We saw most terns close to the coast with just a few sightings out at sea (Table 8). Our observations include both Common Terns *Sterna hirundo* and Arctic Terns *Sterna paradisaea,* but because of the lack of good diagnostic characteristics for reliable species identification, we have grouped our data together. Only adults were observed along the three transects. The high count in the offshore zone in August may indicate migratory movement.

10. ALCIDS

We saw five alcid species during the transects: Razorbills *Alca torda,* Common Murres *Uria aalge,* Thick-billed Murres *Uria lomvia,* Black Guillemots *Cepphus grylle,* and Common Puffins *Fratercula arctica.* It is not always easy to distinguish Razorbills from Common and Thick-billed Murres, but the majority of our observations were made at close range, which permitted us to separate Razorbills from murres. We did not attempt to distinguish between Common and Thick-billed Murres.

a. RAZORBILL

We recorded only four Razorbills during the three transects. All four sightings were made on the 18 July in inshore (3) and offshore (1) waters.

b. COMMON and THICK-BILLED MURRES

The murres were the most common seabirds observed (Table 9). In June we saw them mainly in small flocks (5 to 10 birds), but occasionally these flocks combined to form large groups (observed maximum: 200 birds). At times they appeared as continuous dense waves for several minutes.

Murres were present in high numbers in the coastal and inshore zones, but were most abundant in the offshore water. A large breeding colony of murres exists at Funk Island, which probably accounts for the observed distribution of these birds. In mid-July most murres at Funk Island have chicks and some movement away from the colony by adults with their chick has begun. By late July or early August most murres have deserted their breeding site and moved out to sea (Tuck, 1961). These changes in the stage of the breeding cycle may explain the decrease in the number of birds seen on the 18 July and the relative absence of murres on the August transect.

TABLE 10. — Counts of Common Puffins in the transect zones.

Transect	Coastal	Inshore	Offshore	Total no.
17 June	10	4	21	35
18 July	6	10	1	17
29 Aug.	—	1	1	2

c. BLACK GUILLEMOT

Black Guillemots were observed only on the June transect. Four birds were recorded in the costal zone and two in the offshore zone close to Funk Island.

d. COMMON PUFFIN

Puffins were seen in low numbers along the entire transect in June and July (Table 10). We saw only two puffins on the 29 August.

Summary

This paper describes the total number of seabirds observed during three continuous watches (17 June, 18 July, 29 August 1969) along the same transect line between Valleyfield and Funk Island, Newfoundland. We have attempted to describe the species composition and the seasonal changes in abundance and distribution.

The total number of seabirds seen was highest on the June transect (3,701). It decreased to 1,386 on the 18 July and 91 in August.

Murres were the commonest birds along the transect. Highest numbers occurred in June, while the low was in August. This change may be correlated with the stage of their breeding cycle.

Greater Shearwaters were the second commonest species. Their total numbers were similar in the June and July transects, although a change in distribution had occurred, while few birds were seen on the 29 August.

Fulmars were highest in June with the light-phase plumage predominant. Later, only low numbers of mainly dark-phase birds were encountered.

Gannet densities were similar in inshore and offshore zones in June and July. Lower numbers were seen in August.

Gull distribution was mainly coastal in June and July, but increased to include the inshore and offshore zones by the 29 August.

Low numbers of Sooty Shearwaters, storm petrels, Kittiwakes, terns, and Common Puffins were counted in June and July. Sightings of these species decreased on the August transect.

Jaegers were seen only in June and Razorbills in July.

Acknowledgements

We wish to thank Mr. R. Kardos, McGill University, Montreal, and Mr. J. I. Miller, Memorial University, St. John's, Newfoundland, for assisting in the July and August bird counts. Special thanks go to Skipper A. Sturge, Valleyfield, Newfoundland, and the crew of the "Doris and Lydia" for their co-operation.

We are greatly indepted to Dr. R. G. B. Brown, Canadian Wildlife Service, Aurora, Ontario, for his valuable criticisms of the manuscript and for sending us his Cape Freels — Funk Island April and May 1969 seabird notes. We would also like to express our gratitude to Dr. P. Germain, PIROP, Université de Moncton, Moncton, N.B., for permitting us to use PIROP observations recorded in the transect area; and to Dr. L. M. Tuck and Mr. D. I. Gillespie, Canadian Wildlife Service, St. John's, Newfoundland, and Dr. P. R. Grant, McGill University, Montreal, Quebec, for reading the manuscript.

We also gratefully acknowledge the Canadian Wildlife Service and the National Research Council of Canada for financial support.

Literature Cited

Brown, R. G. B. 1967. Sea Birds off Halifax, March, 1967. Canadian Field-Naturalist 81: 276-278.

Brown, R. G. B. 1968. Sea Birds in Newfoundland and Greenland Waters, April-May 1966. Canadian Field-Naturalist 82: 88-102.

Rees, E. I. S. 1964. The Sooty Shearwater *Procellaria grisea* on the Newfoundland Banks. The Ibis 106: 118-119.

Salomonsen, F. 1965. The geographical variation of the Fulmar (*Fulmarus glacialis*) and the zones of marine environment in the North Atlantic. The Auk 82: 327-355.

Templeman, W. 1945. Observations on some Newfoundland Sea Birds. Canadian Field-Naturalist 59: 136-147.

Tuck, L. M. 1961. The Murres. Canadian Wildlife Series: No. 1, Queen's Printer, Ottawa.

Tuck, L. M. 1967. The Birds of Newfoundland. In *The Book of Newfoundland* (J. R. Smallwood, ed.), Vol. III, Newfoundland Book Publishers Ltd., St. John's, pp. 265-316.

Received November 4, 1969
Accepted May 28, 1970

Observations on Nesting Hawk Owls at the Mer Bleue, near Ottawa, Canada[1]

DONALD A. SMITH

Museum of Zoology, Department of Biology,
Carleton University, Ottawa 1, Ontario

Abstract. After a spectacular incursion of Hawk Owls (*Surnia ulula*) near Ottawa, Ontario in the fall and winter of 1962-63, one pair remained and nested near the Mer Bleue Peat Bog, a boreal 'island' 10 miles SE of Ottawa. This nesting is the first definite breeding record for Southern Ontario and extends the known breeding range in the province 300 miles southeast. The hunting behaviour, small mammal prey, nest site, diverse vocal repertoire, and behaviour near the nest are described.

One of the highlights of the 1962-63 fall and winter seasons in the Ottawa region, as in other parts of southern Ontario and Quebec, was a spectacular incursion of Hawk Owls, *Surnia ulula* (L.), which coincided with high local populations of meadow voles, *Microtus pennsylvanicus* (Ord). The first 1962 fall report of a Hawk Owl in the district was a single bird seen by Rowley Frith of Ottawa at Woodlawn, Torbolton Township, Carleton County on 2 November 1962. Another single bird was seen in Nepean Township near the western outskirts of Ottawa on 3 and 5 November 1962 by Dr. C. Frankton. Further observations of single birds at many localities within the Ottawa area were numerous during November and December but became less frequent in the early part of 1963. The latest Ottawa area record of which I am aware for this winter for a Hawk Owl other than the individuals treated below was one bird seen on 3 February by Mr. and Mrs. H. N. MacKenzie near where Highway 17 crosses the Mississippi River in Fitzroy Township, Carleton County, Ontario.

As Hawk Owls could often be seen repeatedly at the same stations for several weeks or more, it seems likely that the same birds took up residence where suitable high perches were located in adequate hunting grounds. One of the best places for Hawk Owls was in the vicinity of the Mer Bleue a 6300-acre peat bog located about 10 miles southeast of downtown Ottawa in Gloucester Township, Carleton County and Cumberland Township, Russell County. The first Hawk Owl reported there in the fall of 1962 was seen on 18 November by my wife and me, near the east end of the Leitrim Road, the 7th line of Gloucester Township, near Carlsbad Springs. Farther west, two single birds were seen on 24 November 1962 by Dr. G. R. Hanes, one mile NNW and 1½ miles NE of Ramsayville respectively, on the Borthwick Ridge. Probably the most reliable spot to find a Hawk Owl during the ensuing winter and spring was on the eastern half of this four-mile long and 750-yard wide sandy ridge which tapers slightly as it extends east-

FIGURE 1. Adult Hawk Owl on a favorite post beside the Mer Bleue. 19 May 1963.

[1]Contribution No. 5 to the series "Scientific and Cultural Studies of the Mer Bleue" (see THE CANADIAN FIELD-NATURALIST 83(1): 4-6, 1969).

ward about two miles into the southwest corner of the Mer Bleue. The eastern half of the dry ridge is largely meadowland, with scattered trees and bushes or rows thereof bordering most fields, and with two deciduous woodlots. Its damper lower slopes grade through wet meadow to sedge and cattail marshes bordering the black spruce-tamarack-heath bog and support a lush growth of grasses, sedges, herbs and shrubs. This area abounded with meadow voles during late 1962 and 1963, as revealed by sight observations, trapping records, and old nests, runways and cuttings observed after the spring thaw of 1963.

From 8 December 1962 when it was first observed by S. D. MacDonald, many observers saw frequently through the winter and spring what was presumed to be the same Hawk Owl perched in the top of a black spruce or larch in the bog forest north of the ridge near its eastern end. On 16 March, W. E. Godfrey observed two Hawk Owls about 300 yards apart several hundred yards east of the usual winter hunting ground. Thereafter during April, however, a single owl, which we presumed to be the same bird, was frequently seen by Godfrey, MacDonald, my wife and me, usually in one of several tall white elms in an expanse of meadows near the eastern woodlot on Twin Maples Farm, about 1000 yards west of the owl's usual winter location. Then MacDonald's discovery in mid-April that there were still two Hawks Owls (flying over meadows) in this immediate vicinity raised our previously faint hopes that the lingering of these birds beyond winter might be associated with nesting. Accordingly we increased our visits to the area during late April and early May, but on many visits either failed to find the birds, or found just one in one of the previous places.

Finally, on 12 May the first break in the case came when I was able to associate a Hawk Owl with the 6½-acre deciduous woodlot rather than merely with the fields and rows of trees around it. After capturing a meadow vole in a meadow near the end of the Borthwick Ridge Road, the owl flew west, and disappeared around the south side of the woodlot 600 yards away. As two people in a nearby field hadn't seen the owl, I presumed that it had entered the woods. Shortly afterwards, I found a Hawk Owl perched 16 feet above the ground on a branch beside the trunk of a dead red maple, about 50 feet inside the south edge of the woodlot. It remained there with its eyes almost closed for over 20 minutes, only occasionally opening its eyes to look at a nearby noisy and obviously agitated Starling which carried a piece of straw in its beak and probably was building its nest in a cavity in the dead tree.

On 25 May, after being pursued by an Eastern Kingbird, a Hawk Owl flew directly from the east end of the Borthwick Ridge Road around the southeast corner of the woodlot. I went directly to the part of the woodlot where I had watched the owl on 12 May and searched the hummocky floor of the woods between pools of water for pellets or droppings, but found neither. As soon as I spotted a rather damp-looking, scraggly Hawk Owl in a tree just inside the south edge of the woodlot 100 feet to the east, I reclined on the side of a hummock to watch it. The owl gave a series of rising, rasping screeches "screeeeeeeeee-yip" and flew back and forth among the trees along the south edge of the woodlot. Soon a second Hawk Owl appeared carrying a meadow vole in its bill and flew to the broken top of one trunk of a clump of four red maples, about 45 feet inside the woodlot. The owl spread its wings and kept them extended for several minutes. I heard faint squeaks, but the high side of the unevenly broken top of the trunk unfortunately prevented me from seeing the action that must have been going on within the nest, for this was indeed what lay atop the stub, 24 feet above ground level. Over the next five minutes, the owl often moved its wings, occasionally leaned out and looked at me, and then flew off without the vole. One owl remained in the vicinity, screeching repeatedly. It flew occasionally but always perched in high branches. There a Common Grackle squawked and flew at it several times, then flew off. I heard other screeches from the direction of the nest but don't know whether they were made by the young in it or the other adult owl beyond it. The adult owls, which unfortunately I

could not tell apart because of limited visibility in the mosaic of sun and shadow among the foliage, made two more visits to the nest. One visited the nest for less than one minute, then one repeated the previous prolonged wing-flapping performance there. When I stood up after watching the owls for two hours, an adult which had perched for a long time in a tree 80 feet from the nest flew away. As I climbed up the nest tree, an owl appeared and started screaming a strident, hawk-like "kee-kee-kee-kee" or "kip-kip-kip-kip" at me. It perched at nest level 15 feet away and continued screaming until I climbed down and started to walk away, whereupon it became silent.

The internal diameter of the concave, rotted-out top of the stub was seven inches; its irregular rim was only a few inches high on the low side, about 18 inches high on the high side opposite, and it sloped between the two sides. The crumbled, rotten wood floor of the nest was two inches deep in solidly packed damp fur and feathers, reeking of ammonia and crawling with maggots. Upon this unsavory substratum were crouched four greyish-white, downy baby Hawk Owls of graded sizes and one blood-stained, dirty white egg.

When I approached the next morning, 26 May, an adult was in a nearby tree. Over the next 70 minutes it flew to several trees within 100 feet of the nest, screeching and calling "kee-kee-kee-kee" but it did not go to the nest. From the ground we could see and we photographed through a spotting scope the downy heads of several active owlets, upon which flies were landing frequently.

As my wife, W. E. Godfrey, and I approached the woodlot on 29 May, an adult owl flew from a tree in a nearby field along the south edge of the woodlot towards the nest. It flew around giving its "kip-kip-kip-kip" call a few times and the "screeeeeee-yip" call many times, and perched briefly on a post in the field and on several trees on the edge of the woodlot. While we stood in the field, we watched a young owl in the nest repeatedly give a weak imitation of the screeching call of the parent. When I climbed the nest tree, the adult came much closer and continued screeching but the four owlets stopped calling and scrunched down in the nest where they remained still and silent as seen in Figure 2. The largest two owlets were quite well feathered, especially on the wings, compared to four days before. Beneath them was the dirty brown unhatched egg which I collected for the then National Museum of Canada. Since my last visit, many droppings had whitewashed the edge of the nest and adjacent trunks. While I was photographing the owlets in the nest, the second parent flew near carrying a vole in its bill. Both birds flew from perch to perch in nearby trees, the first continuing to call, then the second flew off into the woods.

FIGURE 2. Four young Hawk Owls huddled together in nest depression in broken top of red maple, photographed from directly above. 29 May 1963.

On 31 May, a man working at the nearby farm told me that there was a young "screech" owl with an injured wing (?) on the ground in the woodlot and that its parent "would take your head off if you were to go near the young one"! From the ground I saw owlets moving in the nest and heard them softly 'screeching'. Again they became silent when I climbed up. Only three owlets, now fairly well-feathered beneath their down, were in the nest and a

FIGURE 3. Young Hawk Owl that has recently left the nest. 2 June 1963.

search failed to locate the fourth on the ground or in nearby trees. There was no sign of an adult here, but later I saw one hunting on the north slope of the ridge at the end of the road. This was my last observation of one of the adults; none was seen on either of the next two days' visits, although I did not actually go near the nest on 1 June.

On 2 June, from the field to the south I heard an owlet calling "screeeeeeee-yip" from the nest and another from a point low down in the woods to the west. They became quiet when I entered the woodlot. One owlet was perched on the highest point of the nest tree; a second was in the nest. The third was perched on a tiny stump a few inches off the ground 60 feet west of the nest tree. On my approach, it hissed through its open bill but did not move away. After being picked up and perching on children's hands for some time, the owlet began to screech again and its sibling on the top of the stub did likewise. After I had photographed the first owlet (Figure 3), I put it on the ground at the foot of the nest tree and left temporarily. Mrs. G. R. Hanes watched it walk 15 feet over the leaf litter and climb 20 feet up a straight basswood trunk by flapping its wings and digging in with its long, sharp talons, which earlier had drawn blood from several hands upon which it had perched. This was the last day we saw any of the Mer Bleue Hawk Owls.

On 5 June the nest was empty so I removed the debris therein for examination. The only evidence of the continued presence of the owls since my last observation on 2 June consisted of five fresh pellets found on the ground beneath the nest on 5 June. In the absence of further observations, the fate of the family of Hawk Owls remains unknown. That they should seemingly disappear is surprising, however, and somewhat discomforting to one who had become attached to them, albeit briefly. Likely the young would have been barely able to fly so they would not have been able to move very far. If they had been still living nearby, I would expect them to have been quite a conspicuous group, considering their loud voices, diurnal habits, boldness, and the fact that after young Hawk Owls leave the nest, the family generally remains together (Fisher, 1893).

Food Habits

Observations of recently captured, intact prey carried in the bill or talons of Hawk Owls perched or in flight at the Mer Bleue and elsewhere in the Ottawa area from November 1962 to May 1963 invariably were of meadow voles, *Microtus pennsylvanicus*. The skulls and long bones found in pellets, and a dried, partially consumed carcass picked up under a Hawk Owl perch on a post near the end of the Borthwick Ridge Road were also of meadow voles. One pellet coughed up by a Hawk Owl there while I watched on 19 May contained most of the parts of four *Microtus* skulls but no postcranial material other than a few vertebrae. Fresh pellets found in and under the nest on 31 May contained not only most of the skeleton of a

meadow vole, but also a heavy humerus, some large foreclaws, the peculiar sternum and part of a maxillary bone and three teeth of a star-nosed mole, *Condylura cristata* (L). Later pellets beneath the nest yielded yet more meadow vole bones. The real treasure trove, however, was the stinking mat upon which the young had grown in the nest. It revealed a host of meadow vole bones of all types; the maximum count of any single bone was 18 left mandibles so that an absolute minimum of 18 meadow voles was represented in the remains. The only other prey species whose remains were found in the nest bottom was the tiny masked or cinereous shrew, *Sorex cinereus* Kerr, of which two mandibles, one coxal bone, and several limb bones were found. All feathers in the mat were thought to be from the Hawk Owls themselves.

The conclusion is obvious that the Hawk Owls preyed almost invariably upon meadow voles which were abundant in the Mer Bleue and adjoining meadows and active during the day. Trapping revealed that cinereous shrews were also plentiful in and beside the Mer Bleue during the summer of 1963, and they too are diurnal. Thus the appearance of one in the diet of the Hawk Owls is not surprising, except that one marvels at the ability of the owl to capture such tiny prey. Although we have not taken star-nosed moles at the Mer Bleue, they are not uncommon in the Ottawa area and likely inhabit some of the damper habitats bordering the bog, where one was probably picked up by an owl.

Calls

I recorded notes on three common calls and four occasional ones uttered by the nesting pair of Hawk Owls and their young.

The most common call, usually uttered when an alert adult was perched on a treetop or post in broad daylight as in Figure 1, wagging its tail and looking around actively, (but also given in flight), I refer to as the 'hunting call'. It is an oft-repeated series of three or four or more loud querulous syllables which I recorded in my notes variously as: "queep-queep-queep" or "cheep-cheep-cheep" or "squee-squee-squee". Of these, probably the former best represents the actual call. Note that Godfrey (1966) records one call as "kleep-kleep"; undoubtedly, this represents another interpretation of the 'hunting call'.

When I approached the nest tree and especially when I climbed it, the adults gave two distinct calls, presumably alarm or distress calls. The initial but less frequent one was a rapid, strident, hawk-like series of similar syllables: "kee-kee-kee-kee" or "kip-kip-kip-kip", usually given in flight. More frequent was the raspy, rising, two-parted screech recorded in the field as "screeeeee-yip" or "schreeeeee-yup", with emphasis on the last syllable. This was the call usually given from a nearby perch by an adult owl when I was near the nest. A fainter version of this call was given by the owlets in the nest while I was approaching the tree and an adult was screeching at me, but they stopped it when I neared the nest. I am uncertain whether the owlets gave this call when no one was approaching, but they certainly were doing so on 2 June before I entered the woods, and no adults were seen nor heard. They became quiet as usual when I arrived, but for the first time, resumed screeching later while being handled for photography. The calls "squee-rick or quee-ick" and "kr-r-r-r-e-e-e-eep, a low rapid rattle rising to a cry . . ." cited by Bent (1938) are probably the same as my "screeeeee-yip", as likely are the 'squeals' and 'screeches' reported by Smith (1922). Snyder (1928) stated: "The notes of the young birds are decidedly like those of the broad-winged hawk, except that the high-pitched, hissing sound ascends slightly towards the end." This description too may refer to the same 'screeeeeee-yip' call which was the one most uttered by the young I observed. If so, however, it did not seem to me to describe accurately the calls I heard.

While I was in the nest tree, an adult once called "ha-ha-ha", twice screamed "kee-you" like a Red-shouldered Hawk, and once prefaced the usual "screeeeee-yip" with a brief, loon-like tremolo. When I approached it, one owlet briefly but distinctly hissed at me from its perch just above the ground.

Bent (1938) cites several authors' descriptions of about seven more calls of the Hawk Owl in addition to those described above. This lends weight to his conclusion that "It seems to be a versatile vocalist."

Discussion

Of the observations recorded above, some (the hunting habitats and behavior, exact location and height of the nest, number of eggs, dates for young in the nest, etc.) are within the ranges of variation set forth in Bent (1938) and serve mainly to confirm and augment the relatively few previous records in the literature. The Mer Bleue Hawk Owls' diet of small mammals, mainly meadow voles, conformed to the diets described by Fisher (1893) and Bent (1938), but two members of an order of mammals (Insectivora) not mentioned therein have been added to the list of prey species. The present paper also reports additions to the rather wide vocal repertoire of Hawk Owls, minor interactions with three species of passerine birds, and some different aspects of the behavior of the adults near the nest. For instance, unlike some Hawk Owls described in Bent (1938) and by Dear (1940), these birds were not overly pugnacious and did not fly at me — let alone attack me with their talons — when I was at the nest.

The major importance of the Mer Bleue nesting of the Hawk Owls, however, is that it represents the first definite breeding record for the Ottawa area and in fact for southern Ontario. Eifrig (1911:183) recorded several fall, winter and spring records for the Ottawa area and Lloyd (1944), who described the Hawk Owl as an 'uncommon and irregular winter resident', gave several more fall and winter records. The only possible previous breeding record for the Ottawa area is that of F. Napier Smith (1922) who observed and collected what he believed to be a nesting pair of Hawk Owls on 23 and 24 May 1915 at Lochaber Bay, Papineau County, Quebec, about 16 miles NE of the 1963 nest site. He did not however locate either nest or young. The only other spring records for Ottawa are given by Eifrig (1911) who stated that on 5 April and 8 May, 1908, Mr. E. Bedard shot several Hawk Owls "at the Rifle Range". These records are undoubtedly the basis for the "late date of spring departure" of 5 April and an "unusually late" record for 5 (sic) May given without additional information by Bent (1938: 384). (One wonders if perhaps these owls were about to or had begun to nest when they were shot.)

All of the few previous definite Hawk Owl breeding records for Ontario recorded at the Royal Ontario Museum are from northern Ontario. Amongst these the closest to Ottawa are from Ghost River, Camp 33 and Lowbush in the Lake Abitibi region, Cochrane District, where young were collected in June and July, 1925 by Snyder (1928). These localities are about 300 miles NW of Ottawa. There is in the literature one Ontario breeding record from a locality closer to Ottawa than Lake Abitibi, but the basis of it is unknown. The AOU Check-list's statement (1957) that the Hawk Owl breeds . . . south to . . . central Ontario (Lake Temiskaming) . . . is doubtless based on Bent (1938: 382) who provides no detail other than the locality. Nevertheless, the 1963 nesting near the Mer Bleue, more specifically 2.7 miles ENE of Ramsayville, Carleton County, (latitude 45°23'40"; longitude 75° 31'20") represents a considerable extension of the known breeding range in Ontario. To my knowledge this was the only pair of Hawk Owls that actually nested in southern Ontario after the winter influx of 1962-63, although there was a doubtful breeding record for Cameron, Victoria County in the spring of 1963 (Godfrey, 1966 and personal communication).

The only known summer records of Hawk Owls in southern or central Ontario are sightings of single birds on power lines or exposed dead treetops nearly daily from 22 July to 7 August, and on 22 August 1962, one mile east of Rutherglen, Nipissing District, Ontario by Louise de Kiriline Lawrence (letter dated 16 May 1968). Single birds had been seen in the same place on 13 and 16 November 1961, and were seen later on 1 and 16 November 1962 and 20 January 1963, while other single birds were seen one mile west of Rutherglen on 13 November 1961, 1 November 1962, and 20

January 1963. The existence of summer records about 175 miles WNW of Ottawa suggests the possibility of sometime more widespread nesting by Hawk Owls in central and possibly eastern Ontario where suitable habitat and food are available.

Hawk Owls tend to inhabit open forests or their edges which provide high perches close to open areas presumably well populated by meadow voles. Some of the observations above show that once they had found a suitable winter habitat, at least some Hawk Owls exhibited a marked fidelity for it because they were observed there frequently over extended periods. Provided that the food supply remains adequate, it seems likely that in the future other pairs of Hawk Owls wintering within restricted areas of favorable habitat is southern Ontario might linger and nest. It is suggested that if future observers of Hawk Owls which are 'regular' throughout the winter continue to monitor their whereabouts during the spring and check for nests, using as clues the altered behaviors near the nest reported above, our knowledge of the breeding habits and of sporadic southward extensions of the breeding range of the Hawk Owl might well in time be considerably expanded.

To conclude, it should be noted that probably one of the most significant points about the 1963 Hawk Owl nesting near Ottawa, so far from the usual breeding range of this boreal species, is that such a place as the Mer Bleue existed there. The 1962 fall flight brought many Hawk Owls south of their usual wintering range, but, as stated before, to the best of my knowledge, the only ones that remained to nest were the ones that inhabited the edge of that unique island of boreal peat bog surrounded by agricultural and residential lands on the outskirts of Ottawa — the Mer Bleue. This is a somewhat spectacular but not unprecedented example of the scientific, educational and cultural advantages of having an extensive and accessible boreal ecosystem so close to a center of population and scientific activity. It is fervently hoped that the many scientists, naturalists, educationalists and ordinary citizens of the Ottawa region that cherish the Mer Bleue will be successful in their attempts to have this unique natural feature of the landscape of the National Capital Region preserved indefinitely for the benefit of future generations.

Acknowledgements

I wish to express my thanks to W. Earl Godfrey, S. D. MacDonald and Miss V. M. Humphries, National Museum of Natural Sciences, Ottawa, J. L. Baillie, Royal Ontario Museum, Toronto, and Louise de K. Lawrence, Pimisi Bay, Rutherglen for providing me with some of the supplementary information in this paper; to my wife Lorraine, W. Earl Godfrey, and Anne and Gary Hanes for companionship in the field; and to Andy Selst for his technical help in sorting the contents of the owl pellets. I am also indebted to W. Earl Godfrey and Lorraine C. Smith for their helpful comments on the manuscript.

Literature Cited

American Ornithologists' Union. 1957. Check-list of North American Birds, Fifth edition.

Bent, Arthur Cleveland. 1938. Life histories of North American birds of prey. Part 2. Orders Falconiformes and Strigiformes. U.S. National Museum Bulletin 170: i-xiii + 1-482.

Dear, L. S. 1940. Breeding birds of the region of Thunder Bay, Lake Superior, Ontario. Transactions of the Royal Canadian Institute 23 (Part 1): 119-143.

Eifrig, C. W. G. 1911. The birds of Ottawa (part) The Ottawa Naturalist 24(10): 176-187.

Fisher, A. K. 1893. The hawks and owls of the United States in their relation to agriculture. U.S. Department of Agriculture, Division of Ornithology and Mammalogy, Bulletin No. 3: 1-210.

Godfrey, W. Earl. 1966. The birds of Canada. National Museum of Canada Bulletin No. 203, Biological Series No. 73: 1-428.

Lloyd, Hoyes. 1944. The birds of Ottawa, 1944. The Canadian Field-Naturalist 58(5): 143-175.

Smith, F. Napier. 1922. The American Hawk Owl (*Surnis* (sic) *ulula caparoch*). The Canadian Field-Naturalist 36(4): 68-71.

Snyder, L. L. 1928. The summer birds of Lake Abitibi. pp. 17-34 in: A faunal investigation of the Lake Abitibi region, Ontario by members of the staff of the Royal Ontario Museum of Zoology. University of Toronto Studies, Biological Series No. 32: 1-47.

Received April 24, 1970
Accepted August 2, 1970

Notes

Nesting Activities in a Cliff Swallow Colony

Abstract. Examination of a Cliff Swallow colony in New Brunswick gave information on breeding season and on clutch size, agreeing well with data from studies in western North America. A suggested schedule for timing of visits to nests of passerine birds, to obtain the most important information with minimum disturbance, is based on our experience in this study.

Colonial species are more easily studied than are solitary nesting birds, since the nests do not have to be found individually and since the activities of many pairs are often well synchronized. Among song birds in the north temperate zone, Cliff Swallows *Petrochelidon pyrrhonota* are one of the few colonial species. A number of detailed studies of their nesting habits have been made in western North America (Emlen, 1952, 1954; Myres, 1957; Mayhew, 1958), but much less detail has been noted in the east (cf. Gross, in Bent, 1942).

We made sporadic observations of a Cliff Swallow colony on a farm near Doaktown, New Brunswick, from mid-May to late July 1969. At the time, the farmhouse was being used as a biology field station. The farm, however, had been vacant for the preceding year and contained no farm animals. This perhaps accounted for the scarcity of House Sparrows *Passer domesticus* (two pairs only).

The swallow nests examined were under the north and south eaves of a large woodshed attached to the farmhouse, and under the north eave of a nearby chicken house; several other nests were too high to reach. When we moved into the house in mid-May, there were about a dozen nests, possibly left from 1968; most of the nests studied were built in late May. We checked nest contents on 10 June, 18 June, 26 June, 1 July, and 24 July. On the last check, all but three nests were deserted. Our original records are on file in the Maritimes Nest Records Scheme, c/o New Brunswick Museum, Saint John, New Brunswick.

We estimated laying dates, for nests which contained complete clutches when first checked, by estimating the age of the young birds; from this age, we could back-date by assuming that eggs were laid at one day intervals and that incubation lasted 14 days. Myres (1955) has discussed, at length, procedures for determining dates of nest initiation. Laying dates for nests in which the start

TABLE 1. — Laying dates for Cliff Swallows, Doaktown N.B., 1969.

Laying period	Number of clutches initiated in period: Wood-shed, south wall	Wood-shed, north wall	Chicken house, north wall	Total
29 May-2 June	8	0	3	11
3–7 June	10	6	6	22
8–12 June	8	9	4	21
13–17 June	2	0	0	2
Second nestings 19–23 July	1	1	0	2
Totals (2nd)	28(+1)	15(+1)	13	56(+2)

of laying was dated to a five day period (i.e., to ± 2 days) are included in Table 1. Another 10 nests apparently started in the period of 3-7 June were dated to ± 3 or 4 days, and six more were assigned to the midpoint of the incubation period (i.e., to ± 7 days). At the time of the first check, it was obvious that nesting was later on the north wall of the woodshed than on the south wall or the chicken house. Several nests on the north wall were only partly built and others contained incomplete clutches; some of these nests were later deserted by the birds.

Clutch size (cf. Snow, 1955) is best determined from nests in which the eggs were counted on two visits. If the eggs hatch before the second visit, the number of young then present is acceptable confirmation if it equals the number of eggs present earlier. We did not usually attempt to count young birds, as we were using a mirror and flashlight to inspect the nest contents, so our verified clutch counts were based upon eggs only. Many of the earlier clutches had hatched before our second visit; so we were unable to verify counts of these sets, which averaged larger than the later ones (Table 2). The subsample from the north wall of the woodshed had a clutch size somewhat lower than that of the others (Table 3). This was expected, since nest initiation was somewhat later in this subsample and later clutches tended to be smaller than early ones.

TABLE 2. — Clutch size of Cliff Swallows, compared to laying date, Doaktown, N.B., 1969.

Laying period	No. of nests with clutch				Mean clutch	
	2 eggs	3 eggs	4 eggs	5 eggs	veri- fied	un- ver.
29 May – 2 June	0	0	(8)	(3)	—	4.27
3–7 June	1	3(3)*	14(4)	3 (4)	3.91	4.09
8–12 June	2(1)	4(6)	(7)	0	2.75	3.43
13–17 June	0	2	0	0		
Second nestings 19-23 July	(2)	0	0	—	—	2.00

*Unverified counts are enclosed in parentheses.

This colony of about 100 nests is of the same order as those studied by Emlen (1952) and Myres (1957), but smaller than many reported by Mayhew (1958). Our data (Table 1) suggest that all three sub-areas were colonized by a single wave of arrivals. The delay in nesting on the north wall of the woodshed was probably not due to the slightly cooler environment there — the sun struck the area for only an hour or so in the early morning — for nesting on the north wall of the chicken house, with similar illumination, was not later than on the warmer south wall of the woodshed (cf. Myres, 1957). More likely, it was due to the presence of a pair of House Sparrows, which took over a swallow nest on the north side of the woodshed. The three nests immediately east of the one usurped by the sparrows were empty on all checks (eggs could have been laid and destroyed before our first visit). The two nests to the west were deserted during laying, or early in incubation, and the one beyond them was empty on all visits. The one pair of sparrows apparently influenced all swallows nesting along about one-third of the 20 foot length of the north eave (cf. Samuel, 1959), and may have been wholly responsible for the observed delay in clutch initiation.

TABLE 3. — Clutch size of Cliff Swallows, compared to exposure, Doaktown, N.B., 1969. Confirmed and unconfirmed counts combined, second nestings excluded.

Sub-sample	No. of nests with clutch				Mean clutch (sample)
	2 eggs	3 eggs	4 eggs	5 eggs	
Woodshed, south wall	2	8	19	6	3.83(35)
Woodshed, north wall	3	6	10	2	3.52(21)
Chicken house, north wall	0	4	9	2	3.87(15)

We obtained no useful data on nest success or failure. Only seven occupied nests were known to have failed before our visit on 1 July; some others were deserted before laying began. No dead birds were found in or below nests on 24 July, when flying young were all around the house, so most pairs probably raised their broods to flight. Three nests, including one not used in the earlier nesting, contained eggs in late July. Although swallows may have been occupying these nests at that time, they could not have reared young in time to leave the areas with the other swallows in late August (cf. Foster, 1968).

The data on clutch size (mean 3.74 eggs) and laying date (median 5 June, interquartile range 4-9 June) are very similar to those found in western North America. Our most important conclusions are on methods of study.

Obviously, we should have checked the colony at least once during the main laying period, about 5 June. We should have made a visit soon after 10 June, rather than on 18 June, to confirm the clutch sizes of the earlier nests. And, most important, we should have checked the nests around 4-8 July to determine how many nests reared young to flying age. Counting young is desirable, but would likely cause undue disturbance in these enclosed nests; Mayhew (1958) used artificial nests for this purpose. There was no indication that our four visits caused any mortality in the Cliff Swallow colony, and the added information would certainly justify making the following six checks:

(i) during laying;
(ii) 3-5 days later, for clutch completion;
(iii) 3-5 days later, for clutch size;
(iv) 9-10 days later, for hatching;
(v) 3-5 days later, for survival of young; and
(vi) 3-5 days later, for fledging.

Literature Cited

Bent, A. C. 1942. A. O. Gross, "Northern Cliff Swallow", pp. 463-484, *In* Life Histories of North

American flycatchers, larks, swallows, and their allies. U.S. National Museum Bulletin, 179, 555 p.
Emlen, J. T. 1952. Social behaviour in nesting Cliff Swallows. Condor, 54: 177-199.
Emlen, J. T. 1954. Territory, nest building, and pair information in the Cliff Swallow, Auk, 71: 16-35.
Foster, W. A. 1968. Total brood mortality in late-nesting Cliff Swallows. Condor, 70: 275.
Mayhew, W. W. 1958. The biology of the Cliff Swallow in California. Condor, 60: 7-37.
Myres, M. T. 1955. The breeding of Blackbird, Song Thrush and Mistle Thrush in Great Britain. Part I. Breeding seasons. Bird Study, 2: 2-24.
Myres, M. T. 1957. Clutch size and laying dates in Cliff Swallow colonies. Condor, 59: 311-316.
Samuel, D. E. 1969. House Sparrow occupancy of Cliff Swallow nests. Wilson Bulletin, 81: 103-104.
Snow, D. W. 1955. The breeding of the Blackbird, Song Thrush, and Mistle Thrush in Great Britain. Part II. Clutch-size. Bird Study, 2: 72-84.

ANTHONY J. ERSKINE
STANLEY M. TEEPLE

Canadian Wildlife Service,
Ottawa
March 4, 1970
Accepted October 9, 1970

New Samples of the Piscifauna of Insular Newfoundland

Abstract. Fish collections composed variously of *Salmo salar* L., *Salvelinus fontinalis* (Mitchill), *Gasterosteus aculeatus* L., *Apeltes quadracus* (Mitchill) and *Pungitius pungitius* (L.) were obtained from eight of 14 sampling sites only recently made accessible by road, in central and eastern Newfoundland. Obligate freshwater species remain unreported in insular Newfoundland.

Scott and Crossman (1964) surveyed the piscifauna of numerous waterways adjacent to the mainline of the Canadian National Railways in insular Newfoundland. However, some extensive areas were inaccessible to them. The present survey extends the sampling to the hinterland south of Grand Falls along the recently completed road to St. Albans on the south coast, and to the broad peninsula north of the Trans Canada Highway between Notre Dame Bay and Bonavista Bay (Figure 1). The survey was conducted during the interval, July 21 to July 31, 1969.

FIGURE 1. Map of insular Newfoundland indicating sample sites. Closed circles mark sites at which fish were collected; open circles indicate barren sites.

Numerous potential sampling sites, particularly shallow lakes (known as "ponds", locally), could not be sampled by seine-net because of the boulder-strewn basins. Also, stream-channels were mostly either obstructed by boulders or were partially filled with deep deposits of unconsolidated sand and silt which hampered sustained wading and netting. Consequently, of the 14 sites which were sampled, collections were obtained with a large dip-net. Fish were captured at only eight sites (Figure 1).

Members of two families, Salmonidae and Gasterosteidae occur in these collections. The five species are,

Salmo salar Linnaeus, Atlantic salmon
Salvelinus fontinalis (Mitchill), brook trout
Gasterosteus aculeatus Linnaeus, threespine stickleback
Apeltes quadracus (Mitchill), fourspine stickleback
Pungitius pungitius (Linnaeus), ninespine stickleback

Collections

The locations and dates for collections are listed together with species present, and the numbers of each in the samples.

No. 1 Tributary to south branch of Great Rattling Brook, 16 km south of Trans Canada Highway on St. Alban's road. July 21.
Salvelinus fontinalis (5)
Gasterosteus aculeatus (2)

No. 2 Jonitons Brook at highway No. 40. July 22.
Salmo salar (2)
Gasterosteus aculeatus (8)

No. 3 Long Pond, 3 km east of Boyds Cove. July 22.
Gastrosteus aculeatus (8)

No. 4 Brook at highway No. 40, 5 km east of Doating Cove. July 22.
Salmo salar (1)
Salvelinus fontinalis (3)
Gasterosteus aculeatus (20)
Pungitius pungitius (16)

No. 5 Brook at highway No. 40, halfway between Shalloway Bk. and Anchor Bk. July 23.
Pungitius pungitius (4)

No. 6 Rocky River at highway No. 32 near Markland Avalon Peninsula. July 31.
Gasterosteus aculeatus (4)

No. 7 North Harbour River at highway No. 6, Avalon Peninsula. July 31.
Gasterosteus aculeatus (27)
Pungitius pungitius (10)

No. 8 Brackish barrachois, Pointe Verde, Avalon Peninsula. July 31.
Gasterosteus aculeatus (129)
Apeltes quadracus (25)

These collections are stored in the Department of Biology, Dalhousie University.

Although negative results do not serve the process of proof, the relative paucity of species and individuals in the present accumulations emphasizes the degree of depauperation of the piscifauna revealed by the survey of Scott and Crossman (1964). Such widely distributed but obligate freshwater species as minnows (Cyprindae) and suckers (Catastomidae) have yet to be located on the island of Newfoundland. However, the drainage systems of the Great Northern Peninsula, particularly those of the western slope, have not been investigated so their species distributions are not known. Excepting a few deliberate introductions, invasions from the sea by euryhaline fishes probably have provided the only source of repopulating species for the island following recession of the Wisconsin glaciation. However, the possibility exists that the salinity of water of the relatively narrow Strait of Belle Isle could have been sufficiently reduced by the meltwater of the receding ice that some of those freshwater species which occur in Labrador and Quebec could have become dispersed and established in the developing drainages on the western side of the Peninsula.

Literature Cited

Scott, W. B., and **E. J. Crossman.** 1964. Fishes occurring in the fresh waters of insular Newfoundland. Dept. of Fisheries. Queen's Printer. Ottawa, pp. 1-124.

E. T. GARSIDE

Department of Biology,
Dalhousie University,
Halifax, N.S.
Received May 25, 1970
Accepted September 20, 1970

Conflict Between Dall Sheep and Caribou

Inter-specific tolerance and close association is characteristic of ungulates in some warm environments, where animals of three or more species may intersperse without social or territorial conflict in the same restricted area. Estes (1967) noted that no obligatory inter-relationships are known in ungulates, and he separated their associations into two categories as follows: Firstly, "neutral" or "chance" associations reflect the bringing together of two or more species by environmental factors, such as occurs on a green pasture in the East African dry season (neutral association), or when a grazing and a browsing animal feed side by side (chance association). Secondly, "positive" associations are demonstrated when an isolated member of one species joins a group of another species possibly to satisfy instinctive gregariousness. Possibly a third category occurs which, in its effects at least, suggests a form of social parasitism. At intraspecific levels, non territorial animals appear to associate with territorial males for reasons of "security", since the latter are rela-

tively conspicuous to a predator and less ready than others to take flight (Leuthold 1966). Inter-specific associations may encourage predators to be selective and concentrate their attentions on animals of one species because they are slower or less wary than animals of other species, or because they are calving while others are not.

Inter-specific associations of ungulates are conspicuously rare in temperate biomes. Noteworthy comments appear from time to time describing associations between isolated deer and cattle (for instance: Dansie 1969), and associations between different species of deer are, apparently, even more rare. Although three or four species of deer may inhabit the same forest (Cadman 1967) and obviously share some common environmental requirements, their inter-relationships rarely include direct social interaction.

In comparison to tropical and temperate biomes, the high latitudes support few species of ungulates and each is widely divergent from the others in its morphology, behaviour and environmental requirements. Despite some overlap in habitat, the three ungulate species of interior and northern Alaska (moose, *Alces alces,* caribou, *Rangifer tarandus,* and Dall sheep *Ovis dalli*) are ecologically divergent and rarely experience physical proximity. In some regions only one of these species finds suitable environment; such as the extensive Tanana Valley lowlands where a dense population of moose is present. In the Alaska Range to the south of this region, moose generally prefer the lower elevations where riparian willows (*Salix sp.*) occur; Dall sheep exploit the steep sided canyons, high basins and inter-connected ridges; and caribou largely occupy intermediate environment including foothills, plateaux and middle elevations on the sides of broad valleys. However, caribou are less predictable than moose or Dall sheep. Their highly nomadic behaviour takes them through all types of mountain environment, and they exhibit no territorial behaviour apart from modified versions illustrated in winter by feeding competition in areas of locally shallow snow and by defence of feeding craters in deep snow areas (Henshaw 1968a, 1968b).

During extensive field studies of caribou I observed interactions between this and another species on only two occasions. Both instances involved a moose which wandered close to a caribou band, and on both occasions the caribou took flight although the moose indicated no reaction to them.

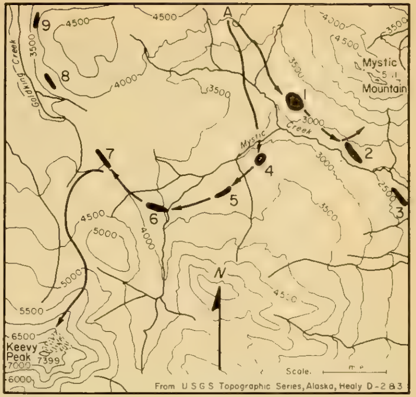


FIGURE 1. Dispersal of caribou by Dall sheep. See text for explanation.

A. Cunningham (to whom I am grateful for a well recorded observation) has described a conflict between Dall sheep and caribou that occurred in the Alaska Range on 18 September 1968, while he was acting as guide to a hunting client. Two bands of caribou, both composed predominantly of large bulls, were found feeding in a broad valley in environment typical of this species. The location of these bands is indicated in Figure 1, at points 1 and 4. The bands consisted of about 100 and 35 animals respectively, and the sequence of the conflict was as follows: Two Dall sheep rams, both about 4-6 years old, moved down from point "A" towards the larger band (point 1). They moved quite slowly and fed from time to time until they were within about 400 yards of the caribou. The rams then broke into a trot, picked up speed and galloped directly at the caribou. The caribou became alarmed as soon as the sheep began to trot towards them, and a number of individuals exhibited the "excitation jump" (described by Pruitt 1960) which often precedes flight. Before the sheep reached the caribou the latter bunched together and ran down to point 2, where they settled down and began to feed. The rams repeated their tactic of slow initial approach and occasional feeding, followed by a trot and then a rapid dash at the caribou. This time the caribou fled to point 3, slowed down and walked away from the area. The rams then turned

uphill and were lost to view in the folds of Mystic Mountain.

About 5 minutes after the two rams moved downhill from point "A", a third ram appeared and moved down towards the smaller band of caribou (point 4). His tactics and the response of the caribou were identical to those already described. The ram drove the caribou to point 5 and twice more, to points 6 and 7. The ram then watched the caribou move out of the area (via points 8 and 9), after which he crossed the valley and moved up to the high slopes of Keevy Peak.

Apart from the wide numerical discrepancy, it should be noted that Dall sheep are considerably smaller than caribou, and the caribou were displaced from habitat typical to them and atypical to sheep. Both Dall sheep (Geist 1968) and caribou (Henshaw 1968b) exhibit distinct patterns of agonistic behaviour at intra-specific levels. However, the literature does not illustrate interspecific aggression in either species. The occurrence described here cannot readily be explained in terms of territorial competition as the caribou did not encroach upon typical sheep habitat. Nevertheless, alternative explanations may be even less appropriate. The protracted driving of caribou was too purposeful to be interpreted as "sport" or "play" behaviour.

The area in which the event took place is on the northern edge of the Alaska Range, and contains fewer sheep and fewer locations of ideal or typical sheep habitat than are found in adjacent areas to the south (confirmed by personal observations in 1968). In terms of vegetation types and "escape topography", the area is marginal sheep habitat, and this factor probably induces greater social and environmental stresses to sheep than occur in more favourable habitats. The rams' aggressive response to the caribou perhaps reflected these stresses rather than competition for food resources, since the caribou were at low elevations in vegetation types that sheep very rarely utilize. The stresses may have been aggravated by the "insecure" position of the sheep prior to the conflict, since they were on a hillside with no escape topography behind or above them. It is pertinent that the sheep moved into steeper ground following the conflict. The ease with which the sheep moved the caribou may be explained by the latter's nomadic disposition and their lack of "tenure" of any specific location in their summer and early autumn range.

Literature Cited

Cadman, W. A. 1967. The deer of the New Forest. Deer, 1, 121-127.

Dansie, O. 1969. Red Deer in Hertfordshire. Deer, 1, 313-315.

Estes, R. D. 1967. The comparative behavior of Grant's and Thomson's gazelles. Journal of Mammalogy 48: 189-209.

Geist, V. 1968. On the interrelation of external appearance, social behaviour and social structure of mountain sheep. Z. Tierpsychol. 25: 199-215.

Henshaw, J. 1968a. The activities of wintering caribou in northwestern Alaska in relation to weather and snow conditions. International Journal of Biometeorology 12: 18-24.

Henshaw, J. 1968b. A theory for the occurrence of antlers in females of the genus *Rangifer*. Deer 1: 222-226, errata 274.

Leuthold, W. 1966. Variations in territorial behaviour of Uganda kob. Behaviour 27: 214-257.

Pruitt, W. O. 1960. Behavior of the barren-ground caribou. Biological Papers of the University of Alaska. No. 3, 44 pp.

JOHN HENSHAW

Box 593,
College, Alaska 99701, U.S.A.
Received November 20, 1969
Accepted March 15, 1970

Conflict Between Red Squirrels and Gray Jays

Intermittent observations made in an area of mixed white spruce (*Picea glauca*) and black spruce (*Picea mariana*) forest near College, Alaska, revealed the existence of agonistic behaviour between red squirrels (*Tamiasciurus hudsonicus*) and Gray Jays (*Perisoreus canadensis*).

The area supported (summer, 1969) a dense population of red squirrels and 5 adults were seen regularly in about 1600M^2 of forest where most of my observations were made. These individuals occupied overlapping home ranges and frequently exhibited symptoms of territorial competition, such as vocal threat and physical harassment involving chases both on the ground and through the upper branches. Competitive behaviour subsided at

night or during heavy rain when forays by squirrels were less frequent and relatively short in distance.

Gray Jays permanently occupy the general area but are opportunistic rather than territorial, foraging through the forest in loose associations of 2 to 4 individuals without remaining stationary to any one location for any length of time.

Conflicts between members of the two species occurred quite frequently when one or more jays foraged close to a squirrel, and particularly when the latter was active around a midden. The actual conflicts invariably reflected an attempt by a squirrel to drive a jay (or jays) away from the former's territory. In this the squirrel was invariably successful, although it often required repeated "rushing" before a jay would fly more than a short distance. Conflicts occurred both on the ground and in the trees, occasionally resulting in physical contact between the animals. Such contacts were consistently brief and resulted either in the squirrel being pecked by a jay or the latter losing a few feathers to the squirrel. No conflicts were seen to result in death or even in obvious injury.

A flying squirrel (*Glaucomys sabrinus*) which occupied the area for about 20 days was also harassed by red squirrels. On three evenings I observed a red squirrel "rush" the flying squirrel, causing it to glide away from its chosen location.

Most authors treat physical conflict over territory as a purely intraspecific phenomenon, a rather short sighted view which suggests that species adaptation to niches occurred (and continues to occur) as a pacific process. However, Wynne-Edwards (1962) and Fisher (1964) acknowledge the problem of aggressive territorial competition between different species and quote examples to illustrate its reality. Fisher (op cit) regards interspecific aggression as an "overspill" from intraspecific territorial behaviour. He classifies this overspill as either: hypersthenic — based on a surplus of drive and possibly involving mistaken identity; or as taxogenic — possessing potential as an evolutionary mechanism. Within this framework, one can interpret the red squirrel behaviour described here as territorial in origin and function. Although such phenomena may be quite rare, we should not ignore the possible significance of physical inter-specific competition to broader problems in population dynamics, biomass and niche adaptation.

Literature Cited

Fisher, J. 1964. Interspecific aggression. In: The natural history of aggression (Eds. J. D. Carthy & F. J. Ebling), Academic Press, London & N.Y., 7-14.

Wynne-Edwards, V. C. 1962. Animal dispersion in relation to social behaviour. Oliver & Boyd, Edinburgh & London, 653 p.

John Henshaw

Box 593,
College, Alaska, 99701.
Received November 20, 1969
Accepted March 15, 1970

First Canadian Record of the Bigmouth Shiner, *Notropis dorsalis* (Agassiz)

Abstract. Bigmouth shiners, *Notropis dorsalis* (Agassiz), were collected in fish samples taken from the Pembina River and two of its tributaries in Manitoba. This record establishes the first occurrence of this species in Canada. Some characteristics of the species and observations on distribution in Manitoba are provided.

During the summer of 1968, the fish species, bigmouth shiner — *Notropis dorsalis* (Agassiz), was seined in Manitoba from the Pembina River and two of its tributaries. This occurrence record extends the range of the species northward and adds a new species to the Canadian faunal list.

N. dorsalis was apparently first recorded in North Dakota by Hankinson (1929) who obtained "a few specimens" from the Pembina River. Hinks (1943) then included it as a "possible Manitoba species" but the first identified specimens from this province are those reported here. Our search was prompted by the reports of Underhill (1957) and Copes and Tubb (1966) who found the species in tributaries of the Red River in both Minnesota and North Dakota.

All *N. dorsalis* collected were in the size range 55 to 64 mm., standard length (S.L.). Some surficial features which helped distinguish the species were:

head shape — long; flattened ventral surface
eyes — superolateral position

TABLE 1. — Fish species collected at each site sampled in the Pembina River system of Manitoba, 1968.

Species	Sampling sites (Fig. 1) and no. of fish collected				
	No. 1 Pembina River	No. 2 Pembina River	No. 3 Snowflake Creek	No. 4 Pembina River	No. 5 Long River
Notropis cornutus	3	59	4	1	0
N. dorsalis	57	12	1	12	2
N. stramineus	54	38	0	0	0
Pimephales promelas	11	68	26	53	19
Rhinichthys atratulus	1	0	0	0	0
Rhinichthys cataractae	0	0	10	21	1
Semotilus atromaculatus	9	2	4	0	0
Catostomus commersoni	0	3	1	22	0
Culaea inconstans	0	0	6	0	0
Percopsis omiscomaycus	9	0	0	2	0
Etheostoma nigrum	2	0	0	1	1
Percina maculata	1	0	1	1	0

snout — long; projecting slightly beyond mouth
mouth — large, horizontal
upper jaw — longer than eye diameter
predorsal area — covered by exposed scales
dorsolateral scales — weakly outlined with dark edges
anterior lateral scales — exposed surfaces less than 2.0 times as high as wide
mid-dorsal stripe — conspicuous but narrow
lateral band — absent or only vaguely apparent

Further peculiarities of the species were garnered from some measured details of a sub-sample of 18 specimens:

anal fin rays — 8
lateral line scales — 35 to 39; mean 36.8; S.D. = 0.56
scales above lateral line — 5
scales below lateral line — 5
body length (S.L.): head length — 3.71, S.D. = 0.05
head length: eye diameter — 4.00, S.D. = 0.14
snout length: eye diameter — 1.27, S.D. = 0.05
head length: snout length — 3.16, S.D. = 1.10
intestine length — shorter than standard length
pharyngeal teeth — 16 × 1,4 — 4,1; 1 × 0,4 — 4,1; 1 × 1,4 — 4,0

These observations generally accord with species descriptions given by Bailey and Allum (1962), Cross (1967), Hubbs and Lagler (1967), Trautman (1957), among others. One exception is the disposition of the mid-dorsal stripe. Trautman indicated that it does not surround the base of the dorsal fin. Our observations were to the contrary; in every Manitoba specimen collected thus far the mid-dorsal stripe was divided at the dorsal fin base and continued around it.

The existance of three subspecies is suggested by Trautman (1957) who depicts their distribution in a range map. One sub-species, *N. dorsalis keimi* Fowler occurs in restricted areas in Pennsylvania and New York while another, *N. dorsalis piptolepis* (Cope), is western and occurs in parts of Colorado, and Wyoming (Hubbs and Lagler, 1967) and Kansas (Cross, 1967). These authors indicate that the intervening region is occupied by *N. dorsalis dorsalis*. By geographical inference, *N. d. dorsalis* is likely the subspecies found in Manitoba. According to Cross (1967) this subspecies is distinguished from *N. dorsalis piptolepis* by having distinct, exposed, predorsal scales. The nape and predorsal area of the latter subspecies is naked. The predorsal area on all Manitoba specimens is covered by exposed scales.

N. dorsalis was found at five locations (Figure 1) in the Manitoba part of the Pembina River that was sampled. Table 1 lists the number of each species collected. Cross (1967) indicated that *Pimephales promelas* and *Notropis stramineus* are frequent associates of *N. dorsalis* since they occupy similar habitats. *P. promelas* was abundant or at least common at all locations where *N. dorsalis* was found in the Manitoba samples. *N. stramineus* oc-

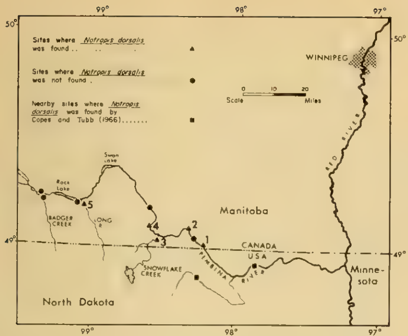


FIGURE 1. Fish sampling sites on the Pembina River system.

curred in two samples, both at the downstream end of the river. Underhill (1957) stated that *N. stramineus* tends to inhabit larger streams and it is possible that the upper Pembina River and the tributary streams contain less desirable habitats for this species.

The Pembina River is a low gradient stream (2.6 feet/mile) with interspersions of sandy (derived from shale materials) and silty substratum. The three sites which contained *N. dorsalis* were in or near sandy areas. Long River and Snowflake Creek have steeper gradients (7.6 and 18.0 feet/mile, respectively). Both streams are intermittent in the upper reaches but are sustained at their lower ends by springs. Bottom materials in the vicinity of the sample locations are chiefly sand and gravel. These habitat situations accord with those described for the species by Bailey and Allum (1962) and Hubbs and Lagler (1967).

It is surprising to us that *N. dorsalis* apparently has not penetrated farther into Manitoba since ingress is not prohibited. The supposed preference of the species for sandy substratum may be a factor in this regard. Waters in much of the Red River basin have muddy bottoms characteristic of glacial lake origins. Extensive fish collections have not been made in Manitoba so that if the species exists only in isolated pockets it may have been overlooked. However, *Notropis dorsalis* is not a distinctive fish and other collectors may not have differentiated this species from other species of the genus e.g., *N. stramineus* and *N. blennius.*

The status of *N. dorsalis* in Manitoba should be investigated so that if increases in abundance, as has happened in South Dakota (Bailey and Allum 1962), or extensions in its distribution occur, the changes may be documented.

Acknowledgment

The fish samples comprised two sources: collections made by J. J. Keleher with the assistance of Gloria Keleher and collections made by the Canada Land Inventory program in Manitoba. Messrs. G. C. Nelson, D. Ayotte and K. Loader, of the Canada Land Inventory (Manitoba) assisted with the latter collections. Mr. Chris Seifert, Canada Land Inventory, prepared the figure. Dr. James C. Underhill, University of Minnesota, made the initial identification of some of the specimens. A subsample was forwarded to Dr. W. B. Scott at the Royal Ontario Museum, Department of Ichthyology and Herpetology, who confirmed the identification. These latter fish are on file with the museum under Accession No. 618.

Literature Cited

Bailey, Reeve M. and **Marvin O. Allum.** 1962. Fishes of South Dakota. Misc. Publ. Mus. Zool. U. of Michigan, No. 119: 131 pp.

Copes, Frederick A. and **Richard A. Tubb.** 1966. Fishes of the Red River tributaries in North Dakota. Contributions Institute of Ecological Studies, Univ. of North Dakota, No. 1: 26 pp.

Cross, Frank B. 1967. Handbook of fishes of Kansas. Misc. Publ. Mus. Natural History, Univ. of Kansas, No. 45: 357 pp.

Hankinson, T. L. 1929. Fishes of North Dakota. Paps. Michigan Acad. Sci., Arts and Letters 10(1928): 439-460.

Hinks, David. 1943. The fishes of Manitoba. Manitoba Dept. Mines and Natural Resources. 102 pp.

Hubbs, Carl L. and **Karl F. Lagler.** 1967. Fishes of the Great Lakes region. Univ. of Michigan Press, Ann Arbor, Michigan. 213 pp.

Trautman, Milton B. 1957. The fishes of Ohio, with illustrated keys. Ohio State Univ. Press, Columbus, Ohio. 683 pp.

Underhill, James C. 1957. The distribution of Minnesota minnows and darters in relation to

Pleistocene glaciation. Occas. Pap. Minnesota Mus. Natur. Hist. No. 7. 45 pp.

ALEX N. FEDORUK[1]
J. J. KELEHER
D. C. WINDSOR

Manitoba Department of Mines and Natural Resources,
Winnipeg, Manitoba.
[1]Now Consulting Biologist,
1010-191 Lombard Ave.,
Winnipeg 1, Manitoba
Received May 8, 1970
Accepted June 4, 1970

Redpoll Nesting at Saskatoon, Saskatchewan

Abstract. An extralimital and unusually early redpoll (*Acanthis* sp.) nesting at Saskatoon, Saskatchewan is documented. It could not be determined what redpoll species was involved. The birds relined a nest of the previous year. Date of laying of first egg is estimated as 7 to 12 April 1970. It is speculated that abnormally mild weather (10-25 April) induced the breeding and that low temperatures (after 25 April) and lack of food caused the death of the three nestlings on 30 April.

This note documents an extralimital and unusually early nesting of redpolls at Saskatoon, Saskatchewan.

On 29 April 1969, at 1800 hours, I found that a nest from the previous season in my back yard (119-109th Street, Saskatoon) contained three young birds and one egg. This nest was about 7.5 feet off the ground in the crotch of a 13-foot Manitoba maple (*Acer negundo*), about one yard from a shack. From 1900 to 2100 hours I observed the nest with a 20x telescope. At 1950 and 2017 hours a parent bird arrived. The first bird, somewhat smaller than a House Sparrow (*Passer domesticus*), had a red-brown spot on the head, slightly forked tail, blackish seed-eater bill, two whitish wingbars and a pale, faintly streaked rump. The second bird had a red spot on the forehead, dark chin, streaked back (with a touch of white) and two whitish wingbars. The rump was not pale. The birds had their back towards me when feeding the young.

I identified both birds as redpolls (*Acanthis* sp.) but was not sure about the species. Houston (1963) described the problem of redpoll identification. When I carefully approached the nest at 2200 hours I saw no bird slipping away or on the nest. On 30 April, at 0800 hours, no parent bird was on the nest. At noon I found the young dead and removed the nest and its contents.

The infertile egg was blown, measured (.64" × .50") and identified by Mr. J. A. Slimmon, Saskatoon, as either Pine Siskin (*Spinus pinus*) or redpoll. No Hoary Redpoll (*Acanthis hornemanni*) eggs were available for comparison.

Dr. W. E. Godfrey (pers. comm., 12 August 1969), National Museum of Natural Sciences, Ottawa, wrote:

> "The egg fits well our series of 14 sets of the Common Redpoll [*Acanthis flammea*] and is definitely more bluish than any of the five sets of Pine Siskin eggs in our collection. I compared the egg also with those of other passerines that had red on the top of the head. The egg, amazing as it seems, is in my opinion that of a redpoll. I cannot be sure, however, which species of redpoll is concerned.
>
> "The appearance of the egg, combined with your observation of the parent birds, leaves little doubt that the birds were redpolls, but we cannot be sure which species."

Dr. Godfrey went on:

> "I have compared the nest with seven nests of the Common Redpoll in our collection. Its lining is thinner than any of them, with less depth of willow and feathers. Otherwise it could pass as the nest of a redpoll."

Both the Hoary and the Common Redpoll have a circumpolar breeding distribution, the latter more widespread in northern Canada than the former. There are no breeding records of Hoary Redpolls for Saskatchewan, the nearest being Churchill, Manitoba (Godfrey, 1966). Nero (1963) described two nests for the Common Redpoll in extreme northern Saskatchewan, about 470 miles north of Saskatoon. Lahrman and Nero (1961) reported an extralimital Common Redpoll nest at Mortlach, Saskatchewan — about 120 miles southeast of Saskatoon — in low shrubbery about 14 inches above the ground. The birds were nesting in early June and had five young.

In the Arctic, both Hoary and Common Redpolls breed in dwarf trees and shrubs, on the ground, or in rock crevices (Godfrey, 1966). Clement (1968) reported Common Redpoll nests at Indian House Lake, Quebec, at 56°12′ N. latitude, on "branches out from the trunk of a small spruce, or in the crotch of an alder or willow, and from 3 to 6 feet off the ground, usually about

5 feet." Apparently the highest reported redpoll nest was at 7 feet (Baldwin and Reid, 1955). The redpolls' nest in Saskatoon was unusually high (7.5 feet off the ground). However, the birds used an old nest (species unknown) which they apparently lined with new, soft material.

The use of the same nest for a number of years has been reported by Wynne-Edwards (1952) for the Hornemann's Redpoll (*A. h. hornemanni*) and the Greater Redpoll (*A. f. rostrata*) at Baffin Island. He also mentioned that a pair of Lesser Redpolls (*A. f. cabaret*) in Scotland relined a used nest and brought up a brood of young. Clement (1968) stated that no one has yet reported that the Common Redpoll uses the same nest from one year to the next.

The young birds, four hours after being found dead, weighed 6.32, 7.77 and 8.22 g. According to Grinnell (1943, 1947) newly hatched Common Redpolls at Churchill, Manitoba, weighing less than 1.5 g increase steadily and rapidly in weight until the ninth day, when they are 12 g. Walkinshaw (1948), writing of Hoary Redpolls in Alaska, gave the weight of newly hatched young as 1.3 g and of seven-day-old nestlings as 6.5 g. Using this information, the lightest bird may have been four to seven days, the heaviest six to nine days old. The incubation period (interval between the laying and the hatching of the last fertile egg) was established as 11 days for both Hoary and Common Redpoll (Baldwin and Reed, 1955; Clement, 1968).

Assuming that eggs were laid on four consecutive days the first egg may have been laid on 7 to 12 April. This is unusually early. In northern Quebec, for instance, June seems to be the peak month for nesting activity of the Common Redpoll (Clement, 1968). Bailey (1928), recording an unusually early nest, stated that his native collector reported a redpoll nest with eggs at Teller, Alaska, on 10 April. No date is given for the first egg. Hatching occurred before 26 April.

The Monthly Meteorological Summary for Saskatoon, Sask. (D.O.T., 1969) for April 1969 reported:

> "April began with temperatures below normal for the first week. Unusually mild air then moved into the district by the 10th of the month and persisted until the 25th. During this period temperatures ranged from 4 to 23 degrees above normal. The warmest day was the 22nd with a temperature of 76, one degree short of the record of 77 in 1933. The temperature of 73 recorded on April 13th surpassed the previous high of 72 set in 1918."

This unusual weather may have been an important factor both in inducing the breeding and in the failure to rear the young. The change in temperature from below to above normal after an unusually cold winter plus the availability of an old nest may have been factors that induced nesting. On 26, 27, 28, 29 and 30 April minimum temperatures were 28, 27, 27, 37 and 33°F, respectively. The young may have died from a combination of exposure to low temperatures and lack of food.

Baldwin (1968) stated that Hoary Redpoll young are fed a mash of seed kernels and, sometimes, insect larvae. Clement (1968) mentioned that "Like most seed-eating fringillids, the [Common] redpoll takes insects when they are abundant, especially when feeding the young." Although insect larvae were probably not abundant in April in Saskatoon, seeds were available and it is, therefore, surprsing that the adults fed the young only twice on the evening of 29 April.

The egg, young and nest are now part of the ornithological collection of the Department of Biology, University of Saskatchewan, Saskatoon.

I would like to thank Dr. W. E. Godfrey and Mr. J. A. Slimmon for the identification of the egg, and Dr. J. B. Gollop, Canadian Wildlife Service, for his help in preparing this note.

Literature Cited

Austin, O. L., Jr. 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. United States National Museum Bulletin 237. Smithsonian Institute Press, Washington, D.C., Part 1. 602 p.

Bailey, A. M. 1928. Early nesting of the redpoll in Alaska. Condor 30: 320.

Baldwin, P. H. 1968. *In* Austin, 1968.

Baldwin, P. H., and **E. B. Reed.** 1955. *In* Austin, 1968.

Clement, R. C. 1968. *In* Austin, 1968.

D.O.T. 1969. Department of Transport, Meteorological Branch, Monthly Meteorological Summary for Saskatoon, Sask. April 1969. 6 p.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada Bull. No. 203. Queen's Printer, Ottawa. 428 p.

Grinnell, L. I. 1943. *In* Austin, 1968.

Grinnell, L. I. 1947. *In* Austin, 1968.

Houston, C. S. 1963. Redpoll identification — a problem. Bird-Banding 34: 94-95.

Lahrman, F. W., and **R. W. Nero.** 1961. A Common Redpoll nest record for southern Saskatchewan. Blue Jay XIX: 113-114.

Nero, R. W. 1963. Birds of the Lake Athabasca Region, Saskatchewan. Saskatchewan Natural History Society, Spec. Publ. No. 5. 143 p.

Walkinshaw, L. H. 1948. *In* Austin, 1968.

Wynne-Edwards, V. C. 1952. Zoology of the Baird expedition (1950). I. The birds observed in central and south-east Baffin Island. Auk 69: 353-391.

HANS BLOKPOEL

Canadian Wildlife Service,
Prairie Migratory Bird Research Centre,
Mobile No. 1,
Saskatoon, Sask.
Received February 15, 1970
Accepted October 30, 1970

Cold Tolerance in Some Adult Fleas (*Ceratophyllidae*: *Siphonaptera*)

Abstract. The adults of four species of ceratophyllid fleas were found to exhibit cold tolerance. *Orchopeas sexdentatus* and *O. leucopus* survived temperatures of −10 to −15°C for periods of one week and 85 days, respectively. *O. howardii* and *Ceratophyllus idius* also exhibited cold tolerance. All the species are regular winter inhabitants of above ground nests.

Although many insect larvae can survive long exposure to sub-zero cold, most adult insects are very limited in cold tolerance. However, despite the assertion by Ashina (1966) that adult insects always suffer fatal injury by bodily freezing, even at high sub-zero temperatures, a recent paper by Miller (1969) reported survival of a carabid beetle, *Pterostichus brevicornis*, after exposure to temperatures ranging down to −87°C.

In discussions of cold tolerance in insects, the literature on fleas seems to have been neglected. Dr. Miriam Rothschild (1965) indicated that the European rabbit flea, *Spilopsyllus cuniculi* (Dale), can survive exposure to temperatures near or below 0°C. for periods up to nine months. She stated, however, that it would not survive prolonged exposure to temperatures of −10°C. Since this flea is primarily a burrow-inhabiting species, survival over long periods at such low temperatures would seem to be of little significance. Data from our studies indicate that several species can survive much lower temperatures. Such tolerance of cold is probably characteristic of species which parasitize mammalian hosts spending the winter in above-ground nests or which overwinter in abandoned bird nests above ground.

On two occasions, specimens of the common deermouse flea, *Orchopeas leucopus* (Bak.), were placed in a freezer at approximately −15°C. These fleas were on snap-trapped mice, in small plastic bags. Individuals remained alive and became active when brought to room temperature after 60 days in one case, and 85 days in the other. Specimens of *Orchopeas sexdentatus* (Bak.) have also been kept in a freezer at −10°C. and remained alive after one week. *Orchopeas howardii* (Bak.) has been removed from between layers of frozen leaves in nests of the gray squirrel, and such individuals, though totally quiescent when found, became active when brought to room temperature. All of these species are found in the adult stage throughout the winter, and all are commonly found in the above-ground nests of their hosts. While these nests provide some protection from the cold, especially when a host mammal is present, there is no doubt that they often reach temperatures of well below zero C for long periods.

Nest boxes of the tree swallow and the purple martin often contain large populations of the flea, *Ceratophyllus idius* Jord. and Roths; as far north as southern Canada. We have examined martin houses during every winter month, and these fleas are always present as adults throughout the winter. Specimens in plastic bags, with no protection from the weather other than the small quantities of dust found in the bottom of the nest, have survived exposures of −10 to −25°C for periods of up to three weeks. Most of these fleas, upon examination, were found lying on the plastic, quite unprotected and totally quiescent. When brought into a warm room, they returned to full activity within a few minutes. Since winter temperatures in the northernmost parts of the range of this species often range down to −35°C often for weeks at a time, the species is exposed to sub-zero temperatures for long periods.

Darskaya (1954) studied the size, number and distribution of fat bodies in a number of fleas of the genus *Ceratophyllus*. She reported that the species which parasitize birds in above-ground nests (*Ceratophyllus delichoni* Nordberg and others) have more numerous and larger fat bodies than do species such as *Ceratophyllus gallinea* (Schrank) which infest ground nests or burrow nests. Since it is known that freezing tolerance in some insect larvae is achieved by an increased level of glycerol during winter (Salt, 1961), it seems likely that some mechanism for the release of glycerol from these fat bodies permits the fleas to

survive extremes of cold. The relatively long survival time at low temperatures reported here also suggests survival of adult ceratophyllid fleas by freezing-tolerance rather than by supercooling.

Literature Cited

Asahina, E. 1966. *In* "Cryobiology", edited by H. T. Meryman. Academic Press, N.Y. Page 463.

Darskaya, N. F. 1964. On the comparative ecology of bird fleas of the genus *Ceratophyllus*. Ektoparazity 4: 31-180. [In Russian].

Miller, L. K. 1969. Freezing tolerance in an adult insect. Science 166(3901): 105-106.

Rothschild, Miriam. 1965. Fleas. Scientific American 213(6): 45.

Salt, R. W. 1961. Principles of insect cold-hardiness. Annual Review of Entomology. 6: 55-74.

DONALD H. MILLER

Department of Science,
Lyndon State College, Lyndonville, Vt.

ALLEN H. BENTON

Department of Biology,
Concord College, Athens, W. Va.

Received May 27, 1970
Accepted September 11, 1970

Brant Breeding on Bylot Island, N.W.T.

On July 1, 1969, I observed a pair of American Brant (*Branta bernicla hrota*) near what I considered to be their nest on the southern coast of Bylot Island, N.W.T. I did not see either goose arise from the nest, but noticed two Brant, presumably a male accompanying a female when they were some several feet from the nest. When disturbed both geese behaved in a manner strongly suggesting that they were defending a nest. Both birds were capable of flight. The nest was down lined and on a four - to five-foot wide hummock in the middle of a small pond which was about 30 feet wide. The pond was one of several on a small plateau about one mile from the shore of Elipse Sound and 400 yards west of a large glacier-fed creek.

I returned to the nest site on July 3 and found that it had been destroyed, presumably by an avian predator. The remains of two eggs were found. The two Brant were still in the area along the shore of the creek. They were vocal and reluctant to fly when approached.

I did not see either goose on the nest at any time. However I believe the following points are significant:

(1) The nest site and type was typical of *Branta* spp.
(2) Both birds behaved in a manner highly suggestive of nest defence.
(3) Both birds retreated very slowly when I approached the nest site.
(4) The geese were the only waterfowl seen in the immediate area on July 1 and July 3 at the time the nest area was visited.
(5) The geese remained in the area after the nest had been destroyed.

The above points led me to conclude that the nest was that of the Brant. Tuck and Lemieux (1958) and others mentioned by the above authors, observed Brant in the area of Bylot Island, but failed to record them as breeding there. To my knowledge the present report is the first breeding record of the American Brant on Bylot Island.

Literature Cited

Tuck Leslie M. and **Louis Lemieux.** 1959. The avifauna of Bylot Island, Dansk Ornithologisk Forenings Tidsskrift, 53: 137-154.

J. DOUGLAS HEYLAND

Department of Tourism, Fish and Game,
Quebec Wildlife Service,
Parliament Buildings,
Quebec, Quebec.

Received December 1, 1969
Accepted October 30, 1970

The Common Starling In Arctic Quebec

Recently Mr. J. D. Furneaux, former northern administrator for the Canada Department of Indian Affairs and Northern Development, Povungnituk, Quebec reported to me that on May 14, 1968 a Common Starling (*Sturnus vulgaris*)

was seen and subsequently captured at Povungnituk (60°02′ N, 77°13′ W). Mr. Furneaux kept the bird in his home until it was accidently killed on May 20. On that same day two more starlings were seen in the village. On May 17 five or six starlings were seen at Povungnituk. Some of these got into an equipment garage where one of the Eskimos trod on one in his enthusiasm to catch a specimen. That same day the remainder departed inland.

Between May 14 and 20 Dr. Nelson Graburn of the University of California at Berkely reported a flight of six or seven starlings at Sugluk on Hudson Strait (62°13′ N, 75°38′ W). These birds remained for only a short time (J. D. Furneaux *pers. comm.*).

Since its introduction in North America in 1890-91 the starling has spread over much of the continent. However it has seldom been reported outside of forested areas. Both Povungnituk and Sugluk are situated well north of the tree line and in true arctic tundra habitat. Only few observations of the species above the 60° parallel have been reported (Fuller, 1955; Kuyt, 1965; Stewart, 1966).

The observation made at Sugluk must compete with that of Kuyt for the northern record. Testimony to the rarity of the starling in the Povungnituk area is the fact that the Eskimos had never seen one before and therefore did not have a name for it. It was finally dubbed Qirngitagalik (phonetic spelling) meaning "The Dark One".

On January 3, 1968, W. E. Godfrey, National Museum of Natural Sciences received a letter from Mr. K. G. Ellard, Toronto, Ontario, which contained the following paragraph.

"Last July while I was at Fort Chimo, Quebec, a flock of about 180 starlings was seen. Fort Chimo is 212 air miles north of the rail line at Schefferville, Quebec. Mr. James Ford who manages the Shell Oil Co. at Fort Chimo said that the starlings were first seen in 1966, when about 15 birds were spotted. The birds are nesting in gas drums which have been stored in rows several tiers high with bungs removed. This past summer is the first time that starlings have nested that far north in this part of Quebec. They have made a remarkable journey over a tough bit of terrain".

The 180 starlings were observed during July 1967. This was also the year in which the nesting at Fort Chimo took place.

A previous northern record for Quebec was made at Fort MacKenzie by Bleakney (1953).

Literature Cited

Bleakney, Sherman. 1953. Starlings in the Ungava District, Quebec Province, Canadian Field-Naturalist, 67: 44-45.

Fuller, W. A. 1955. First record of the starling in Northwest Territories. Canadian Field-Naturalist 69(1): 27.

Kuyt, Ernie. 1965. A breeding record of the starling at Lookout Point, Northwest Territories. Blue Jay, 23(2): 83-84.

Stewart, Robert E. 1966. Notes on the birds and other animals in the Slave River — Little Buffaloe River area, N.W.T. Blue Jay, 24(1): 22-32.

J. DOUGLAS HEYLAND

Department of Tourism, Fish and Game,
Quebec Wildlife Service,
Parliament Buildings,
Quebec, Quebec.
Received December 1, 1969
Accepted October 30, 1970

Whistling Swans Breeding on the Northwest Coast of New Quebec

Reported observations of the Whistling Swans (*Olor columbianus*) in Quebec and Labrador are few. Todd (1963) does not accept the observations of Barnston's (1860) claim of "swans" hatching near Eastmain on James Bay. In fact the only observations for Quebec and Labrador that he claims to be valid are those listed by Packard, Austin and Comeau (all *in* Todd, 1963) for the Labrador coast and the north shore of the St. Lawrence River.

Todd (1963) notes that it is found breeding on Digges Islands (62°35′ N., 78°0′ W.) which lie in Hudson Strait just west of Cape Wolstenholme. It was first recorded there by Feilden and Woodworth in 1886 (Todd, 1963).

Godfrey (1966) indicates that it breeds on the Belcher Islands, Mansel and Nottingham Island, but he had no breeding record for the Quebec mainland. He stated that it was a "... scarce transient in extreme eastern Ontario and southwestern Quebec".

During the course of annual aerial surveys of waterfowl in July and August, 1962, the second andthird authors observed pairs of swans along the northeast coast of Hudson Bay between

Inoucdjouac (Port Harrison) and Cape Wolstenholme, Quebec. This area, lying within an area of recently emerged land, is subarctic in climate and is typically tundra habitat. They recorded pairs of swans in the same area in 1963, 1964, and 1965. They first observed broods of cygnets in July 1966. During the summer of 1967 all authors recorded several broods in the same general area and on July 20, 1967, a class I cygnet was collected. It was subsequently identified as a Whistling Swan by W. Earl Godfrey of the National Museum of Natural Sciences, Ottawa, and is now in the collection of the Quebec Wildlife Service (No. 422). During 1968 additional broods of Whistling Swan were observed. In all 24 broods of cygnets have been recorded (Table 1).

TABLE 1. Numbers, age-class, locations of and dates upon which Whistling Swans have been observed along the northeast coast of Hudson Bay, Quebec, 1966 to 1968.

Date	*Age Class and No. in Brood*	*Location* Lat.N. Long.W.
Aug., 1966	II — 3	62°15′, 77°30′
Aug., 1966	II — 5	61°30′, 77°30′
Aug., 1966	II — 5	61°25′, 77°30′
Aug., 1966	II — 4 and II — 3	61°50′, 77°30′
Aug., 1966	II — 3	59°50′, 77°30′
Aug., 1966	II — 4 and II — 3	61°55′, 77°30′
Aug. 4, 1967	II — 3	61°11′, 77°40′
Aug. 4, 1967	II — 3	61°43′, 77°45′
Aug. 4, 1967	II — 4	60°07′, 77°20′
Aug. 4, 1967	II — 3	59°20′, 77°40′
Aug. 9, 1967	III — 3	60°54′, 77°53′
Aug. 1, 1968	II — 4	60°13′, 77°20′
Aug. 9, 1968	II — 2	59°46′, 77°16′
Aug. 10, 1968	III — 3	59°38′, 77°25′
Aug. 11, 1968	III — 3	60°48′, 77°55′
Aug. 12, 1968	III — 4	59°20′, 77°43′
Aug. 18, 1968	III — 4	59°08′, 78°06′
Aug., 1968	II — 1	60°12′, 77°20′
Aug., 1968	II — 2	60°23′, 77°35′
Aug., 1968	II — 2, II — 3, II — 3	59°15′, 77°00′

In addition to adults with broods, 19 pairs of swans without cygnets were noted in 1967 and 1968.

We believe that the above observations represent the first definite breeding records of Whistling Swans in Quebec and Labrador. It is apparent that the species has successfully pioneered the northeast coast of subarctic Quebec and that the number of breeders is increasing.

The authors express their appreciation to Dr. W. E. Godfrey for his critical review of the paper.

Literature Cited

Barnston, George. 1860. Recollections of the Swans and Geese of Hudson's Bay. *Ibis*, July, 1860. Pp. 253-259.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada, Bulletin No. 203, Biological Series No. 73.

Todd, W. E. Clyde. 1963. Birds of the Labrador Peninsula and Adjacent Areas. University of Toronto Press, Toronto. pp. 819.

J. DOUGLAS HEYLAND[1]
EVERETT B. CHAMBERLAIN[2]
CHARLES F. KIMBALL[2]
DONALD H. BALDWIN[3]

[1]Department of Tourism, Fish and Game, Quebec Wildlife Service, Parliament Buildings, Quebec, Quebec.
[2]Migratory Bird Populations Station, Patuxent Wildlife Research Center, Laurel, Maryland, U.S.A.
[3]47 Duggan Ave., Toronto, Ontario
Received December 1, 1969
Accepted October 30, 1970

The Use of Late Tertiary Fossil Wood as Nesting Material by Rough-legged Hawks on Banks Island, N.W.T.

Abstract. The use of late Tertiary fossil wood as a major nest building material by Rough-legged Hawks is recorded. This wood is derived from the Beaufort Formation where it occurs in wood lenses.

During the summer of 1968, John Fyles (Geol. Surv. Can.) and I found a pair of nesting Rough-legged Hawks (*Buteo Lagopus s. johannis* Gmelin)) on the west side of Ballast Brook in Northwestern Banks Island 11 kilometres inland from M'Clure Strait. In addition five abandoned nests within 11 kilometres of the active nest were found. (See Figures 1, 2, 3 and 4).

The active nest in 1968 was about 2.5 metres broad at the base and 2.5 to 3 metres high and was composed almost entirely of fossil wood of an extinct species of *Picea* (Hills & Ogilvie 1970). Only a single piece of willow (*Salix arctica*), which grows in the vicinity of the nest was found incorporated into the nest structure. The nest was lined

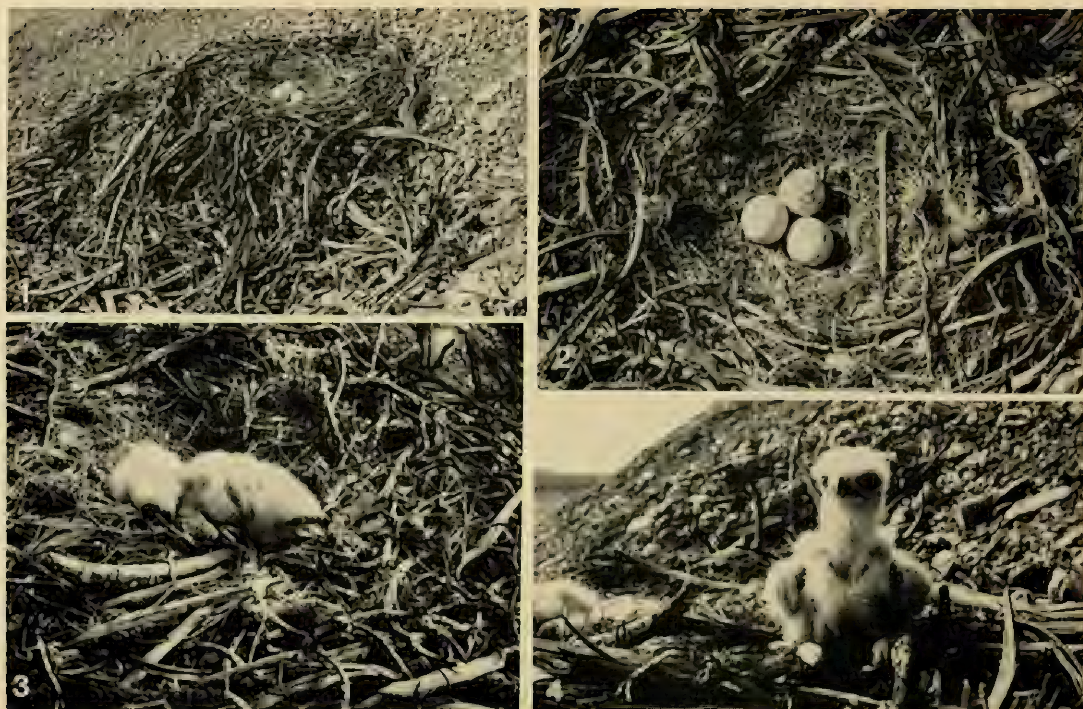


FIGURE 1. Nest illustrating shape and position on talus slope. Note all the wood is fossil and has probably been collected from the talus slope.

FIGURE 2. Nest and eggs. Nest is lined with grass and a few feathers. The lower nest is composed of large wood fragments whereas small fragments are utilized in the lining of the nest. Pencil is about 15 cm in length.

FIGURES 3 and 4. Young rough-legged hawks less than two weeks old. Both photographs are the same magnification.

with grass and a few feathers. The wood fragments ranged from less than a centimeter in diameter and 4-5 centimetres in length to 5 centimetres in diameter and 1 metre in length. Most of the fossil wood was probably gathered directly from the slope on which the nest was built. The abandoned nests were also constructed of fossil wood.

All of the wood fragments examined from the nests were hardly or not at all petrified. The specific gravity of the wood when dry is only slightly heavier than dried wood from an extant tree.

This wood comes from the remains of a Late Tertiary (Late Miocene or Early Pliocene) i.e. not less than 6 million year old coniferous forest which is preserved within the gravels of the Beaufort Formation.

Literature Cited

Hills, L. V. and **Ogilvie R. T.** 1970. *Picea banksii* n. sp. Beaufort Formation (Tertiary), Northwestern Banks Island. Canadian Journal of Botany 48:

L. V. HILLS

Associate Professor of Geology
The University of Calgary
Calgary 44, Alberta
Received May 21, 1970
Accepted September 15, 1970

Another Red Bat, *Lasiurus borealis*, Taken aboard Ship off the Coast of Nova Scotia

Abstract. A specimen of a red bat, *Lasiurus borealis*, taken aboard ship, some 90 miles south of Yarmouth, appears to constitute the third known such record off the coast of Nova Scotia. All three bats appear to have been involved in autumn migrations.

"Apparently only two Nova Scotia records are known, both of which were taken on ships at sea" (Peterson, 1966, p. 78). The first, reported by Norton (1930), was based on a specimen taken about August 17, 1929, near the eastern end of George's Bank, about 130 miles south by west from Cape Sable (42°N, 66°W). The second was reported by Brown (1953) and was based on a specimen taken about October 7, 1952, approximately 150 miles south-southeast of Liverpool (42° 42′ N, 62°58′ W).

About the middle of October, 1969 a red bat was discovered early one morning by Mr. Roy Dagley aboard a ship operating out of Lunenburg, Nova Scotia, at approximately 90 miles south of Yarmouth (42°30′ N, 66°10′ W). He preserved the specimen and took it to Mr. Cyril Selig of Boreal Biological Laboratories Ltd., Marine Division, at Vogler's Cove, Nova Scotia, who in turn presented it to the author for the collections of the Royal Ontario Museum. The specimen is an adult female, R.O.M. 57256.

Earlier accounts suggest that the bats taken aboard ship may have been blown off course during their migration by strong winds. Of the three specimens taken off Nova Scotia, one was taken in August and the other two in October. Findley and Jones (1964) found that fall migrations in the hoary bat, *Lasiurus cinereus*, begin in August. It would appear that the red bat follows a similar pattern and that the above three were involved in autumn migrations.

Literature Cited

Brown, N. R. 1953. An addition to the list of the mammals of Nova Scotia, the eastern red bat. Canadian Field-Naturalist 67(3): 139.

Findley, James S. and **Clyde Jones.** 1964. Seasonal distribution of the hoary bat. Journal of Mammalogy 45(3): 461-470.

Norton, A. H. 1930. A red bat at sea. Journal of Mammalogy 11(2): 225-226.

Peterson, Randolph L. 1966. The mammals of eastern Canada. Oxford University Press, Toronto, pp. 1-465.

RANDOLPH L. PETERSON

Department of Mammalogy
Royal Ontario Museum
Toronto, Ontario
Received August 12, 1970
Accepted October 28, 1970

The Brook Stickleback, *Culaea inconstans* (Kirtland); New to Nova Scotia

Abstract. One specimen of the Brook Stickleback, *Culaea inconstans* (Kirtland), was found in a collection of fresh water fish from Cumberland County,

Nova Scotia, May 10, 1970. This is the first recorded occurrence for this species in Nova Scotia.

In the spring and summer of 1970 collecting trips for freshwater fish were made in Cumberland County, Nova Scotia. Since live specimens were needed for modelling purposes and not science collections, the usual scientific sampling procedure was not employed. Specimens were collected with a fine mesh dip net and transported alive to the Nova Scotia Museum.

On the afternoon of May 10, fish were collected in two river systems near the Trans-Canada Highway, the Nappan River south of Amherst and a bog and stream at River Phillip, Oxford area. Specimens from both localities were kept in the same container of water and it was not until specimens were placed in an aquarium at the museum that a stickleback with six spines was noticed. This fish was identified as a brook stickleback, *Culaea inconstans* (Kirtland) 1841. Three subsequent collecting trips were made in these areas without success.

This specimen was in excellent condition and was kept alive in an aquarium for several weeks before being killed, preserved and placed in the Nova Scotia Museum fish collection. The catalogue number is 970-Z-134-1(1).

This is the first recorded occurence of the brook stickleback in Nova Scotia. It is interesting to note that Dr. D. A. Livingstone listed this species in his 1951 paper *The Fresh Water Fishes of Nova Scotia*, page 72. He did not find the brook stickleback during his survey, but included it on the possibility that it might be found in the province at some later date. During the summer of 1955 John S. Erskine and Francis R. Cook investigated the freshwater fishes of mainland Nova Scotia but did not find *Culaea inconstans*. (personal communication with J. S. Erskine).

Acknowledgment

I wish to thank Dr. E. T. Garside, Department of Biology, Dalhousie University, Halifax, for his comments on this manuscript.

JOHN GILHEN

Nova Scotia Museum,
Halifax, Nova Scotia.
Received September 12, 1970
Accepted November 7, 1970

Pomarine and Parasitic Jaegers and Sabine's Gulls in Alberta

The Pomarine Jaeger *Stercorarius pomarinus* appears on the hypothetical list in Salt and Wilk's "The Birds of Alberta"* which indicates that there is at least one sight record for the province but no material evidence for the occurrence of the species in the form of a specimen or photograph. As I am familiar with this jaeger, having previously seen it on the North Atlantic and on many occasions during a three month stay on Banks Island, where I also collected some of these birds, I believe that my observation of a bird of this species in Alberta is worthy of being recorded. It crossed the north shore of Lake Athabaska at Fiddler Point on the evening of June 6, 1969, flying steadily from the S.E. to N.W. at an elevation of about 30 yards. The unmistakable tail was well seen, the well marked breast band (the bird was of the light phase) and the whitish wing "flashes" were also noted.

As there are few records of the Parisitic Jaeger *Stercorarius parasiticus* for Alberta, it may be noted that one was seen on June 6 and 7, 1969, just off Fort Chipewyan. On June 6 it pursued a Ring-billed Gull *Larus delawarensis* for about half a minute in flight. On June 7 two of these jaegers were seen flying on a northwesterly course from a road between Fort Chipewyan settlement and the airport.

The available records of Sabine's Gulls *Xema sabini*, for Alberta curiously enough do not include occurrences in the northern portion of the Province. The presence of a flock of 12-15 of these birds on Lake Athabaska off Fort Chipewyan on June 7, 1969 is therefore worthy of note. My journey was supported by the Boreal Institute, University of Alberta.

E. O. HÖHN

Department of Physiology,
University of Alberta,
Edmonton, Alberta.

*Queen's Printer, Edmonton, 2nd Ed. 1966.

Lark Bunting in Quebec

Abstract. A male Lark Bunting (*Calamospiza melanocorys*) was collected on 13 May 1970, on the south shore of Rivière du Lièvre, in front of Fermeneuve, Labelle County, Quebec. The present specimen appears to be the first known one of this species to be collected in Quebec.

On 13 May 1970, the junior author discovered a male Lark Bunting (*Calamospiza melanocorys* Stejneger) in bright breeding plumage on the south shore of Rivière du Lièvre, in front of Fermeneuve, Labelle County, Quebec. The bird was on a fence post, near a barn and a ploughed land. The specimen was collected by the senior author, and is No. 02568 of the collection of the Department of Biological Sciences of the University of Montreal. Its skull was fully ossified, and its testes measured approximately 11×7 and 10×6 mm. The furculum depression and the intestinal folds were completely filled with fat. Large deposits were also on the abdomen, and smaller ones on pectorals, flanks, and back.

In Canada, the breeding range of this bird is normally restricted to the prairie provinces, as stated by Godfrey (1966):

> "Breeds in southern Alberta (east of the Rockies: west to Calgary and Fort Macleod; north to about Sibbald, Castor, and Youngstown), southern Saskatchewan (Crane Lake, Regina, Indian Head, Kindersly), and southwestern Manitoba (Brandon)."

However, there are some records of the Lark Bunting from the eastern part of Canada, chiefly in migration. Godfrey (1966) writes: "Accidental in eastern Ontario (Lowbush, June 5, 1925; sight record Toronto, September 21, 1941), and New Brunswick (Nantucket Island, August 15, 1910)." Bent (1968) mentions two other records for New Brunswick (Grand Manan, West Quaco). There are also four sight records reported from Nova Scotia (Tufts, 1961).

The first and only sight record of this species was reported for the Province of Quebec by Harper (1958) from Seven Islands on 27 May, 1953. The present specimen appears to be the first known one to be collected in Quebec.

Literature Cited

Bent, A. C. 1968. Life Histories of North American Cardinals, Grosbeaks, Buntings, Towhees, Finches, Sparrows, and Allies. Smithsonian Institution, United States National Museum Bulletin 237, Part 2: 603-1248.

Godfrey, W. E. 1966. The Birds of Canada. National Museum of Canada, Biological Series 73, Bulletin 203: 1-428.

Harper, F. 1958. Birds of the Ungava Peninsula. University of Kansas Miscellaneous Publication 17: 1-171.

Tuffts, R. W. 1961. The Birds of Nova Scotia. Nova Scotia Museum, Halifax, 481 p.

RAYMOND MCNEIL
DENISE DOYON

Department of Biological Sciences,
University of Montreal,
C.P. 6128, Montreal 101,
Quebec, Canada.
Received June 4, 1970
Accepted October 30, 1970

The Record of the Least Bat, *Myotis subulatus* (Say), in New Brunswick

Abstract. The record of the Least Bat, *Myotis subulatus*, for New Brunswick is shown to be invalid.

Peterson (1966) in "The Mammals of Eastern Canada" p. 69, map 15, records *Myotis subulatus* from northwestern New Brunswick. Apparently Dr. Peterson did not see or examine the specimen upon which the record was based, and there is no mention in the text (p. 68-69) in regard to the particular specimen.

Prior to the publication of "The Mammals of New Brunswick" (Squires, 1968) a letter was sent to Dr. Peterson (by Dr. Squires) asking for more information in regard to the record of *Myotis subulatus* in New Brunswick. Dr. Peterson, in reply, stated that the specimen was in the American Museum of Natural History, and was collected at Trousers Lake, New Brunswick. Consequently, Dr. Squires included the Least Bat in his work on New Brunswick mammals.

Several years ago the American Museum of Natural History kindly sent a list of the New Brunswick mammal specimens in their collection to the New Brunswick Museum. There was no mention made of a specimen of *Myotis subulatus*

from New Brunswick. This prompted the author to pursue the matter further, by writing the Mammalogy Department of the American Museum of Natural History.

In reply, Dr. Sydney Anderson, Curator of Mammals stated that the specimen upon which Peterson based his record of *Myotis subulatus* (AMNH 6693/5313) from New Brunswick was first catalogued under that name, but was reidentified as *Myotis lucifugus* by Miller and Allen (1928) U.S. Nat. Mus. Bull. 144 p. 45. Peterson evidently took the name from the old catalogue without himself verifying the identification. Dr. Anderson points out that the identification of the specimen has been rechecked by Dr. Karl Koopman and he regards it as *Myotis lucifugus*.

Therefore, although the Least Bat *Myotis subulatus* may yet be taken in New Brunswick, the one and apparently only record as shown in Peterson's "The Mammals of Eastern Canada" is no longer valid.

STANLEY W. GORHAM

Asst. Curator
Natural Science Department
The New Brunswick Museum
Saint John, N.B.
Received November 18, 1969
Accepted September 14, 1970

Additional Records of Migratory Tree Bats for the Maritimes

Abstract. Additional New Brunswick records are given for Hoary Bat, *Lasiurus cinereus*; Red Bat, *Lasiurus borealis*; Silver-haired Bat, *Lasionycteris noctivagans*.

Bleakney (1965, Can. Field-Nat. 79(2): 154-155) summarized the records of the migratory tree bats for Nova Scotia while Gorham and Johnston (1962, Can. Field-Nat. 76(4): 228) did likewise for New Brunswick. As Bleakney has pointed out, records for migratory tree bats from eastern Canada are exceedingly rare. Since the above notes appeared in press several new records are known. Gesner (1842, Synopsis of the contents of the Gesner's Museum of Natural History at Saint John, N.B., p. 46) lists two specimens of Hoary Bats Nos. 2051♂ 2052♀ under the scientific name "*Vespertilia Pruinosus*" = *Lasiurus cinereus*. Unfortunately Gesner does not state whether the specimens came from Nova Scotia or New Brunswick. Neither specimen can now be located in the New Brunswick Museum's collection. Dobson (1878, Cat. Chiroptera in the British Museum: 273) mentions *Atalapha cinerea* var. *grayi* = *Lasiurus cinereus* as occurring from Nova Scotia to Chile, but he does not refer to the specimen or specimens upon which the Nova Scotia record is based. There is now in the collection of the New Brunswick Museum one specimen of Silver-haired Bat *Lasionycteris noctivagans* Cat. No. 213♂ taken at Little River (Saint John) on Aug. 27, 1898 by A. G. Leavitt. (Squires 1968, The Mammals of New Brunswick: 18, fig.). A Red Bat specimen *Lasiurus borealis* Cat. No. 437 was taken at St. Andrews, N.B. on Oct. 30, 1967 and this specimen is also in the New Brunswick Museum collection. Squires (1960, Nature News, No. 4 p. 3) reports that "a schoolboy brought a Red Bat skin to the museum from Dipper Harbour in 1958, and reported a small colony there."

STANLEY W. GORHAM

Natural Science Department
The New Brunswick Museum
Saint John, New Brunswick
Received September 1, 1969
Accepted September 14, 1970

Wheatear Observations near Fort Churchill, Manitoba

An immature Wheatear (*Oenanthe oenanthe*) was observed August 22, 1968, seven miles east of Fort Churchill, Manitoba (58° 45′ N., 94° 05′ W.). An adult Wheatear was seen September 5, and two adults September 7, three miles east of Fort Churchill. A recent restriction by the Canadian Government prevented collection of these birds. Godfrey (1966) reported that Wheatears nest in northeastern Canada on Ellesmere Island, south to White Island, northern Quebec, and along the coast of Labrador. Individual birds have occasionally been reported during migration in southern Quebec (including Anticosti Island) and in southern Ontario. The A.O.U. (1957) lists the Greenland Wheatear (*O. o. leucorhoa*), which probably represents the subspecies that would migrate through Manitoba, as an accidental winter visitor in New York, Pennsylvania, Louisiana, Cuba and Bermuda.

Neither Taverner and Sutton (1934), Allen (1945), nor Godfrey (1966) list the Wheatear as occurring in the Churchill- Fort Churchill area. It is the writer's belief that these observations represent the first records for northern Manitoba.

Literature Cited

Allen, Arthur A. 1945. Some changes in the bird life of Churchill, Manitoba. The Auk 62(1): 129-134.

A. O. U. 1957. Check-list of North American birds. American Ornithologists' Union, Fifth Edition. 691 pp.

Godfrey W. Earl. 1966. The birds of Canada. Natural Museum of Canada Bulletin No. 203, Queen's Printer, Ottawa. 428 pp.

Taverner, Percy A. and **George M. Sutton.** 1934. The birds of Churchill, Manitoba. Annals Carnegie Museum 23. 83 pp.

CARROLL D. LITTLEFIELD

Department of Biological Sciences
University of Arizona
Tucson, Arizona

Received April 1, 1970
Accepted April 23, 1970

An Observation of Muskoxen near Tree-line at Artillery Lake, N.W.T.

A Fort Smith resident, Mr. D. Bohnet, casually remarked to me that on September 1, 1970 he had seen three muskoxen near the south end of Artillery Lake. The animals were of approximately equal size, had large horns and exhibited the light-brown mid-dorsal spot or saddle. The location was given as "an island or peninsula near the Department of Energy, Mines and Resources water station on the Lockhart River". I checked with pilot W. Harms who had flown Mr. Bohnet into the area and Mr. Harms confirmed the location as "a large peninsula about four miles east of the water station". The geographic location of the trio of muskoxen at the time of observation would then have been about 62°53'N, 108°22'W. Most of the Arctic mainland muskoxen are probably contained within the boundaries of the Thelon Game Sanctuary, where 568 muskoxen were counted in March, 1966 (Tener and Kuyt, 1966). I have seen a few muskoxen south and west of the Sanctuary but almost always along the Thelon and Hanbury Rivers. The present report represents the deepest southwest penetration of the tree-line area in recent time by muskoxen that I am aware of. Hopefully, muskoxen will continue to return to the Artillery Lake area, a welcome addition to the fauna of the proposed National Park in that area.

Literature Cited

Tener, J. S. and **E. Kuyt.** 1966. Muskoxen survey, Thelon Game Sanctuary. Typewritten report in files of Canadian Wildlife Service, Ottawa. 4 p. and map.

E. KUYT

Canadian Wildlife Service
Fort Smith, N.W.T.

Received October 13, 1970
Accepted October 13, 1970

Proceedings of the Ottawa River Conference. Pollution Probe, Carleton University, Ottawa, 1971. 94 pages. This conference held at Carleton University, June 12 and 13, 1970 deals with the many facets of pollution of the Ottawa River. Contributors to the proceedings include scientists, political leaders, representatives of industry, community organizations and an historian. Available for $2.00 plus 14 cents postage from the Ottawa Field-Naturalists' Club, Box 3264, Postal Station C, Ottawa and from Pollution Probe at Carleton University.

Index to Volume 84

Compiled by Mrs. Judy N. Findlay

Information Governing Content of The Canadian Field-Naturalist

Feature Articles

Beginning with the 1970 issues, the Canadian Field-Naturalist will be open for the consideration of major feature articles whose purpose is to make authoritative reviews of outstanding natural history and/or environment issues of our time. If possible, feature articles should be illustrated. Publication costs are open for negotiation between the author, editor and the business manager of the club.

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. Reviews, compilations, symposia, controversial or theoretical papers, historical researches, etc. can also be published. Environmentally related papers are given priority in publication sequence.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect natural history and environment values. This section deals with activities, policies, and legislation relating to land and resource use, national and provincial parks, pollution, natural science education, conservation, natural area and species preservation activites and so on. Contributions should be as short as possible and to the point.

Notes.

Short notes on natural history and environment written by naturalists and scientists are welcome. Extensions of range, interesting behavior, pollination observations, reproductive phenomena, oil and pesticide pollution statistics and many other kinds of natural history observations may be offered. However, it is hoped that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environment values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

Reviews

Normally, only solicited reviews are published. The editor invites biologists and naturalists to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "Other New Titles".

Special Notices and other items

The Canadian Field-Naturalist has a flexible publication policy. Hence an item not falling under any of our traditional sections can be given a special place provided that it is judged suitable.

(See Instructions to Contributors inside back cover)

Instructions to Contributors

Manuscripts

Authors should submit two manuscripts (original and carbon copy), each complete with abstract, tables, and illustrations. Manuscripts should be typewritten on paper measuring 8½ x 11 inches. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Words meant to appear in italics should be underlined. Every sheet on the manuscript should be numbered.

Literature citations should be listed alphabetically according to author and should be placed immediately after the main body of the text in all manuscripts except in letters to the editor. In no case should any words be abbreviated; this includes references to tables and figures as well as literature citations.

The tables should be titled and numbered consecutively in arabic numerals. Tables should be placed each on a separate page after the Literature Cited. Captions to figures should be typed together on one page. Authors are requested to use at least one given name.

The **Style Manual for Biological Journals** is recommended, in general, as a guide to contributors.

Webster's New International Dictionary is the authority for spelling. However, in a case of difference in the spelling of a common name, and in the use of a variant name, a decision of a learned society is preferred.

The order in which papers are published will be as determined by the editor.

Illustrations

All illustrations should be numbered consecutively in arabic numerals. The author's name, title of the paper, and figure number should be written in the lower left corner of the sheet on which each illustration appears. The caption should **not** appear on the illustration.

Line drawings should be made with India ink on white, good quality drawing paper, blue tracing linen, or good quality blue-lined co-ordinate paper. Co-ordinate lines that are to appear on the reproduction should be ruled in black ink. Descriptive matter should be lettered, not typewritten, and all parts of the drawing should permit easy legibility even if a reduction is made.

Photographs should have a glossy finish and show sharp contrasts. For reproduction as a complete plate they should be mounted without space between prints.

For large drawings and mounted photographs the ratio of height to width should conform to that of the printed journal page (ratio of 45 up to 35 across) or roughly 7½ × 5¾ inches, but the height should be adjusted to allow for the caption if the caption is to go on the same page.

Special Charges

Authors are asked to share the cost of publication by paying $22.00 for each page in excess of six journal pages. The cost of illustrations and the setting of tables and of small-sized type are also normally charged to the author.

Reprints

Reprints, with or without covers may be purchased. The cost is given on the reprints order form which is attached to the galley proofs. Members in good standing can request a 10% reduction in reprint costs.

Affiliated Societies

Edmonton Bird Club

President, P. H. THOMPSON; *Honorary President,* R. LISTER; *Past President,* J. C. FINLAY; *Vice-President,* K. W. SMILLIE; *Treasurer,* R. HEATH; *Field-Secretary,* R. W. TURNER; *Audubon Representative,* P. DEMULDER; *Secretary,* MISS M. J. WADE, 6519 94 St., Edmonton, Alberta; *Librarian,* MR. A. W. RUPP, 97 Westbrook Dr., Edmonton 76, Alberta.

Calgary Field-Naturalists' Society

Address: Box 981, Calgary 2, Alberta, *President,* DR. JOHN POWELL; *Vice-President,* PETER KARSTON; *Secretary,* W. GARRY MCKAY; *Treasurer,* MARGARET POWELL; *Directors,* MRS. HATTIE BOOTHMAN and DR. M. T. MYRES; *Editor,* THE CALGARY FIELD-NATURALIST, JOHN W. PRICE.

McIlwraith Field Naturalists' Club

President, MR. TED MADDEFORD; *Past President,* DR. W. H. MINSHALL; *Vice-President,* MRS. SPENCER INCH; *Corresponding Secretary,* MISS MARGARET ROSS, Apt. 9, 179 Oxford Street East, London; *Treasurer,* MRS. WALTER WAKE, 1354 Longmuir Ave.; *Chairman Audubon Films,* MR. G. FRED BATES, 366 Burlington Crescent, London; *Chairman Conservation Council,* MRS. P. W. TRACEY, 261 Briscoe St., London; *Editor,* CARDINAL—DR. FRANK COOK, 1 Larkspur Crescent, London, Ont.

Vancouver Natural History Society

President, MRS. W. J. SMITH; *First Vice-President,* MR. A. W. GREENIUS; *Second Vice-President,* MRS. J. M. ANDERSON; *Treasurer,* MR. E. G. BARNES, Box 3021, Vancouver 3, B.C.; *Corresponding Secretary,* MRS. H. PINDER-MOSS; *Membership chairman,* MRS. E. BARNES; *Editor,* VNHS BULLETIN, MRS. R. A. PILKINGTON.

Nova Scotia Bird Society

President, DR. ERIC MILLS; *Vice-President,* DR. B. K. DOANE; *Past President,* MR. IAN A. MCLAREN; *Editor,* MRS. J. W. DOBSON; *Membership Secretary,* MISS E. CRATHORNE; *Secretary-Treasurer,* MISS M. CLAYDON, c/o Nova Scotia Museum of Science, Spring Garden Road, Halifax, Nova Scotia.

Province of Quebec Society for the Protection of Birds

President, MR. M. D. SPENCER; *Vice-Presidents,* MRS. E. S. COOPER, M. H. OUELLET; *Honorary Treasurer,* MISS G. E. HIBBARD; *Honorary Secretary,* MRS. G. H. WIGHTMAN, 40 King's Rd., Pointe Claire, P.Q.; *Librarian,* MRS. E. BROSSEAU.

Toronto Field Naturalists' Club

President, MR. JOHN A. GINGRICH, 225 Coldstream Ave., Toronto 12, Ontario; *Vice-President,* MR. CLIVE GOODWIN; *Secretary,* MRS. H. ROBSON, 49 Craighurst Ave., Toronto 12, Ontario; *Treasurer,* MRS. F. F. MATHERS; *Editor,* MR. ELMER TALVILA; *Junior Club,* MR. ROBERT MACLELLAN, 416 St. Clements Ave., Toronto 12, Ontario.

The Saskatchewan Natural History Society

Honorary President, FRED G. BARD; *President,* GORDON SILVERSIDES; *Past President,* W. A. BROWNLEE; *First Vice-President,* J. A. WEDGEWOOD; *Treasurer,* GEORGE R. DODD, 33 Malone Crescent, Regina, Sask.; *Corresponding Secretary,* MRS. LEITH KNIGHT, 843 Elgin Avenue, Moose Jaw, Sask.; *Editor,* THE BLUE JAY, GEORGE F. LEDINGHAM, 2335 Athol St., Regina, Sask.; *Assistant Editors,* MARGARET BELCHER and ROBERT W. NERO; *Editor of* NEWSLETTER, JAMES SLIMMON, 2526 Hanover Ave., Saskatoon, Sask.

THE CANADIAN FIELD - NATURALIST

PUBLISHED BY

The Ottawa Field - Naturalists' Club

BOX 3264, POSTAL STATION 'C'
OTTAWA 3, CANADA

Second Class Mail Registration No. 0527
Return postage guaranteed